CIVIL ENGINEERING

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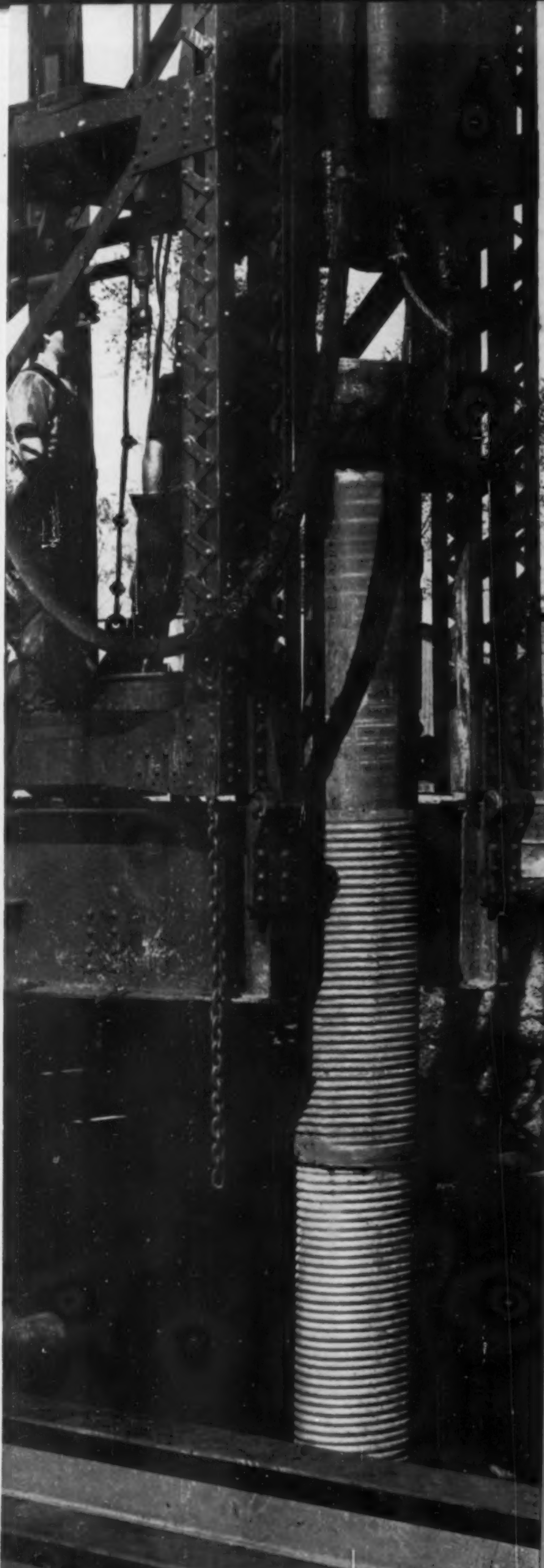
ATLANTIC RAIL TERMINALS AT JERSEY CITY, ONE OF THE MAJOR TRANSPORTATION CENTERS OF THE NATION
Should the Gigantic Industry Typified Here Be Nationalized? Asks a Writer in This Issue

Volume 9 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — Number 10

OCTOBER 1939



Among Our Writers

J. D. Mitsch (Massachusetts Institute of Technology, 1920) has been on the staff of his alma mater almost continuously since graduation. Among his recent activities are service as faculty adviser of the M.I.T. Student Chapter, as placement officer for senior students in civil engineering, and as administrative officer at the M.I.T. summer surveying camp.

Alfred H. Fletcher (Massachusetts Institute of Technology, 1921; also M.S. in engineering from Harvard) spent 5 years as assistant engineer in the state health departments of Tennessee and Louisiana on malaria control work, and has been with the city of Memphis for 12 years—the last 10 as director of the Bureau of Sanitary Engineering.

O. E. Brashears has been county road engineer of Yakima County, Washington, from 1915 to 1918 and from 1923 to date. His duties include the construction and maintenance of all county roads and bridges. Prior to 1915 Mr. Brashears was employed as head of field party by the Reclamation Service and as assistant engineer by the city engineering department of Yakima.

John J. Casey (University of California) has been employed in the Bureau of Engineering of San Francisco for 25 years. Since 1932, as city engineer, he has been responsible for the construction of major structures with an aggregate cost of $10,000,000.

William J. Wilgus entered railroad work in 1885, and in 1899, at but 33 years of age, was appointed chief engineer of the New York Central. A private consultant from 1907 till his retirement in 1931, he was in continuous demand on transportation, municipal, and public utility enterprises. During the World War he served in France as director general of military railways and deputy director general of transportation, and was cited for exceptionally meritorious and distinguished service.

W. J. Quentin is a Major, Military Intelligence—Reserve, U. S. Army. He has had a great variety of engineering experience in Asia, Europe, Africa, and Mexico, and has been with the U. S. Navy Department for the last 10 years.

Henry D. Dewell (University of California 1906) began private practice in 1914 as a civil engineer specializing in structural work. His interest in earthquake-resistant construction began when he was shaken out of college by the 1906 San Francisco earthquake. He has served as Director and as Vice-President of the Society.

F. A. McCaughan (Southern Methodist University 1930) has been in the employ of Myers, Noyes and Forrest (now Myers and Noyes) for the past 5 years, doing general civil engineering work and work on flood control and irrigation projects.

M. J. Dowd (California Institute of Technology), after three years on the Yakima Project with the Bureau of Reclamation, went to the Imperial Irrigation District in 1922 as general water master. Promotion to his present position came in 1925. He is in charge of all District activities, including both irrigation and drainage work—and for the past 6 years power-system design, construction, and operation as well.

W. H. Rayner has taught at his alma mater, the University of Illinois, since 1911. For some years he has been in charge of surveying instruction. In professional practice he has engaged in railroad and municipal engineering and has had charge of governmental topographic and hydrographic surveys. He is joint author of *Surveying* with Davis and Foote, and author of *Elementary Surveying*.

Sherman M. Woodward (M.S., Washington University, 1893; M.A., Harvard, 1896) was from 1908 to 1934 professor of mechanics and hydraulics at the University of Iowa. In addition, he was consulting engineer for the Miami Conservancy District from 1913 to 1920, and for the Chicago Sanitary District, 1925 to 1929; and in 1933–1934 he served on the Mississippi Valley Committee of the Public Works Administration. He has been with the TVA since 1933.

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STATEMENT OF POLICY

The world is entering a crisis, the result of which no one can foresee. Other wars have brought inflation, followed by unemployment and depression after peace was achieved. America's experience in the World War illustrates this fact.

Much of this post-war trouble would have been eliminated by a more foresighted price policy on the part of manufacturers and distributors. Price inflation by the seller when he had a dominant position resulted inevitably in reaction with deflation, depression and suffering. Many of those price increases were not warranted.

Before such an inflationary cycle of prices is again started, we publicly pledge ourselves, as far as possible, to maintain present prices.

Further, if the materials we buy are increased in price, or the cost of labor is increased, then we pledge ourselves to raise selling prices no more than the bare increase in cost of raw materials and labor going into our products.

Further, we pledge ourselves to pass on to our customers the reduction in cost made possible by better manufacturing methods, wider distribution and technical advances in production.

THE LINCOLN ELECTRIC COMPANY

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Status—Why Not?

Engineers as a Group, Different from Other Professions, Face a New Problem, That of Securing Recognition

By J. D. Mitsch

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Assistant Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

TODAY the engineer is confronted by the question, "What regard has the public for me and my work? What of the economic state of the men of my profession?"

For many years he has been interested in the technical problems confronting him in a rapidly developing civilization and now he comes suddenly to an entirely different kind of question. It is a social and economic issue involving the relations between the engineer and the general public—a type of problem foreign to the technical mind, so accustomed to dealing with stresses and strains, figures and formulas, materials and matter.

It offers a challenge as great as that of designing a monumental engineering structure and the goal is worthy of the effort of every man in the profession. The problem is what the engineer has termed the gaining of "status."

Yearning for Prestige.~Considering for a moment the history of the civil engineering profession, we realize that many men have, by their deeds, provided the foundation for a campaign directed toward the attainment of professional "status." Such men as Eads, Chanute, Goethals, Freeman, Waddell, and Ridgway are but a few examples from the recent past.

Many leading civil engineers of today have achieved just as much "status" or prestige as distinguished doctors, lawyers, and architects. Yet we are all aware that the profession as a whole cannot claim this boon for the entire group to nearly the degree that it has been achieved by the other professions. The obvious question then is, "Why have we not accomplished it as a body?"

A careful analysis will show that the problem in the other professions is quite different from ours. The doctor, the lawyer, and to some extent the architect, are practicing professions that deal with what might be termed "personal problems." They are constantly working in terms of close relationship with single individuals. So it comes about that we are all in the habit of using the term, "my doctor," "my lawyer," and at times "my architect." Since they do work in this manner, the individual is only too glad to offer them "status," for as a client he can then point with pride to the man to whom he has entrusted his personal welfare.

Service to Public Overlooked.~But how frequently do we hear the term "my engineer"? Not very often, if ever. This is only natural, as the engineer is not concerned with the personal problems of an individual as such, but with problems that concern the whole group of individuals who together constitute the general public.

One approach to the problem must lead to greater appreciation by the general public of the works of the engineer. That is, the engineer himself must take the steps that will bring about this highly desirable attitude. He should first turn the spotlight on his own professional field to see why, despite his important contributions to social welfare, he has not won public recognition.

I sometimes wonder if the man on the street appreciates the efforts the civil engineer has exerted to meet the growing demands of a faster moving world and a higher standard of living. The engineer pushed our railroads and highways across the country; he brought the water supplies for our great cities; he planned the dams for irrigation and water power; he spanned our great rivers and harbors with daring structures such as the George Washington Bridge and the two bridges over San Francisco Bay. He tunneled under the rivers and through the hills, always with the one thought that his efforts would improve the means of enjoying life in a modern world. He worked always in the interest of the public.

Hiding His Light.~So crowded was his life with technical problems that he neglected to consider his own welfare and that of his fellow workers. He allowed his economic circumstances to remain in the background while he pushed ever forward on his professional problems. He did not even stop to tell the great body politic of his work, for did not his structures speak for themselves? The general public does not, however, listen to the voice of the great engineering structures; and, sad to relate, it has been permitted to take the engineer and his accomplishments for granted.

Quite evidently, the technical man has not yet discovered that to attain public prestige or status he must

interpret his works in terms of personal benefit—prosperity, safety, convenience, happiness for the man on the street, his wife and his children. The engineer, like the physician and the lawyer, must be recognized by the individual as a personal benefactor.

In order to accomplish this, he must educate the public to appreciate that a great engineering structure is the result of the untiring efforts of an expert. It is the product of a period of training starting in the engineering college, extending through years of experience, and culminating in the ability to handle effectively the engineering problems involved in the design of a truly great and efficient structure.

Too Efficient for His Own Good.~Let us glance for a moment at the life of the civil engineer of today and examine his economic position.

The situation is something like this: The consulting engineer is awarded a contract to design a structure. It will require many man-hours of trained technical work, so he looks to the engineering market for help. He finds many well-qualified men available and engages a number of them with the understanding that, upon completion of the contract, their services will no longer be required. It is exactly the same type of agreement that the contractor makes with his common laborers. The work starts and the force directs every effort to preparing plans and specifications which will meet the highest engineering standards.

Personal economic problems are temporarily forgotten for there are many difficult technical problems to be solved. The regular work day is not long enough and so the men are asked to work evenings, holidays, and Sundays. The rush is on and continues day after day until the work is completed.

Then comes the inevitable sad day of completing the project and once again the personal economic problem rushes to the fore. How long will it be until the next job—a day, a week, or a month? A few of the engineers have escaped this dismissal and have been retained on the so-called permanent staff. They too, however, realize that if other work is not forthcoming in the immediate future their salaries will be gradually reduced and eventually they may be dismissed.

Engineer Himself to Blame.~This is the economic system which the civil engineer faces. He organized it that way and now, like Frankenstein, stands in awe of his own creation. Had he planned his personal problem nearly as well as he planned his structure, the picture would be entirely different. The individuals involved are nearly all college graduates, men who have been trained for a better economic life than the one they are required to accept.

In searching for the one responsible for this situation, we cannot fail to come back to the civil engineer himself. He is the man who arranges to do contracts in half the time required by a competent permanent staff. He is the man who agrees to do this for a fee which is far below what should be charged for the efforts of his trained staff.

In a legal case, a person pays for the lawyer's years of training and for the time he has spent without clients. The physician charges a fee sufficient to carry him over the days of low financial return. Likewise business today charges enough for its product so that the executives of a corporation and many of its staff have a feeling of security in their positions. Why does not the engineer make his client pay for services rendered, including the support of a permanent staff over periods of lessened activity? Of course one answer to this question is that competition will take the business at even smaller than prevailing fees.

Cooperation, Now.~But this answer is hardly conclusive if we consider that the best brains of the profession are organized at present in the American Society of Civil Engineers. What a tremendous force these men could exert if they were but to give themselves to the task! It would require the most complete type of cooperation among the engineers, but it would bear results if all applied themselves whole-heartedly to this economic problem of vital importance in the welfare of every engineer.

Cannot recommendations looking toward further educational requirements for the student engineer seeking to enter the profession have merit? Already leading engineering colleges are attempting to enrich their educational programs by broadening their curricula to include studies in the field of the humanities with the hope of inculcating an intelligent understanding of the social and economic implications of engineering. If we await the results of this program to raise a new group of engineers, we are losing much of our present opportunity. Our "frontier" is rapidly disappearing as a result of the efforts of the civil engineer, and our great accomplishments of the past are the best background that could possibly exist for a campaign to attain "status." Steps taken by the profession today will profoundly affect the profession of both today and tomorrow.

To Build Standards as Well as Structures.~Men follow the study and practice of civil engineering because it offers an opportunity to attain one of the greatest joys that comes to man—the thrill of accomplishment. They follow it because, having technical minds, they are fascinated by problems that challenge their ingenuity. They love to conceive a structure and then see it grow into its permanent form. They will probably continue to follow the profession whether or not they gain "status" for their efforts, even though this attitude is responsible for conditions as they exist today. The history of the development of our profession in this country proves there is another side to the engineer's life than the technical which is worthy of serious consideration.

Engineering accomplishment alone is insufficient to bring the just reward. The Engineers Counsel for Professional Development and the Society's Committee on Professional Objectives have endeavored to direct the attention of the engineer to this need for a broader view of his own position in society. The time has now arrived when the engineer is beginning to realize that these agencies have been striving for a very desirable goal.

Feeling strongly that the civil engineer is truly deserving of "status," I hold that the problem of attaining this should be attacked on a broader front than just that of educational standards. We should look in addition to our public relations and to the economic circumstances of the engineer as of today, remembering always that man and profession set their own standard and the world comes to respect it.

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NUMBER 10

Memphis Slum Clearance and Housing Studies

Detailed Social and Economic Surveys of Substandard Areas Yield Information Vital to Planning of Adequate Housing Program

FROM A PAPER RECENTLY PRESENTED BEFORE THE MID-SOUTH SECTION

By ALFRED H. FLETCHER

SANITARY ENGINEER, MEMPHIS HEALTH DEPARTMENT, MEMPHIS, TENN.

SUBSIDY, says Mr. Fletcher, seems to be the best method of approaching the task of slum clearance. He emphasizes, however, that "slum clearance" will actually prove to be but "slum shifting" unless the subsidy actually takes care of the poorest of the poor. The real goal of a subsidized housing program, he says, should be "a rent that slum dwellers can pay—not a rent that will support the project as designed and constructed." Detailed surveys of substandard areas, of the type reported here, will go far towards supplying a basis for the sound planning of a complete program providing some measure of housing improvement for people of all levels of need.

THE Memphis Department of Health is vested with the responsibility of enforcing housing regulations. In an attempt to develop a fundamentally sound housing enforcement program, a series of studies as to the make-up of the Memphis slums has been made. The first housing survey, made in 1933–1934, covered the entire city, and seemed to show a definite relationship between outdoor communal toilets and typhoid fever, and between housing, when grouped according to a housing index, and infant mortality.

A second housing study, covering all substandard areas of the city, was made during 1936–1938. At this time a record of each house or housing unit within these areas was secured. A numerical value or rating was placed on each house surveyed, based on the degree to which it conformed to an arbitrarily set-up minimum standard. A minimum-standard house is defined by the Memphis Health Department as one that is reasonably tight to protect the occupants from the weather, screened for protection against mosquitoes, provided with an inside private wash-down toilet and a water faucet and sink connected to a sanitary sewer, served by a safe water supply, provided with adequate natural light and ventilation, facing a street, and in a reasonable state of repair. By combining the ratings of the dwellings into blocks of dwellings, a picture of the degree of the problem as it varies from block to block or from area to area was obtained. By coloring on a map of the city the lowest-index blocks as yellow, those next best as brown, and so on, using purple, green, and red in the order listed as the blocks improved, it has been possible to put on paper for study, a picture of slum housing conditions so that the cores of bad areas stand out, with the slums radiating from them in varying degrees of dilapidation and insanitation. Figure 1 is such a map, with various types of cross-hatching replacing the color scheme just described.

In 1938 after all the housing units in the slum and substandard areas were surveyed, a third survey of the social and economic status of the families in each housing classification was made by sampling. From 13 to 40 per cent of the families in each housing group were sampled.

These studies have been most helpful in bringing out certain fundamental principles involved in the cause and cure of slums, which in turn have suggested the administrative procedures necessary to the drafting and enforcement of a Housing Code, and the part that subsidized housing should play in a complete housing program.

The substandard area of the city has not only been divided into these five classifications according to the average type of housing in each block, but within each area-classification there are five types of housing. In other words, it is the average housing condition under which the people in each block live that determines the classification of the block. Thus, in the best blocks, either there will be a large percentage of good houses, or a large percentage of the families will be living in reasonably good housing units, whereas in the poorer blocks a large percentage of the housing units will be poor. The substandard area, then, has actually been classified into 25 groups; and the six tables in this paper show how certain social and economic factors vary in these 25 classifications as developed in the family survey. Table I shows the percentage of families in each of the 25 housing-index classifications; Table II, the percentage of colored families in each classification; Table III, the percentage of single-family units in each

TABLE I. PERCENTAGE OF FAMILIES IN EACH OF THE 25 HOUSING INDEX CLASSIFICATIONS

HOUSING GROUPS	AREAS*				
	1	2	3	4	5
1	82.8	53.2	29.18	17.50	5.45
2	6.3	12.7	9.80	4.58	2.72
3	5.7	11.2	10.37	7.32	2.91
4	3.2	10.6	19.78	11.66	8.26
5	2.0	12.3	31.78	60.74	80.66
Total	100.0	100.0	100.0	100.0	100.0

* For significance of area numbers, see legend on Fig. 1.

classification; and Table IV, the percentage of living units owned by the occupants in each classification. Tables V and VI show, respectively, the average rent and the average income per month per family in the 25 housing-index classifications.

It is interesting to note that there is a progressive decrease shown in all but one of these factors from the No. 1, or best, group of houses (rating from 80 to 100 per cent of the minimum standard) in the No. 1 areas, to the No. 5, or poorest, group of houses (rating from zero to 30 per cent of the minimum standard) in the No. 5 areas. The exception is the percentage of colored families in the different housing classifications, in which there is a progressive increase (Table III). The smallest percentage of colored families is found in the best houses in the best areas and the largest percentage is found in the poorest houses in the poorest areas. It is also of interest that in each of these tables the progressive change in the factor under consideration is noted not only as the area ratings change (as shown by the bottom line of each table, marked "totals"), but also as the housing ratings change (as shown by the column at the extreme right marked "totals" or "averages").

Two important conclusions drawn from these studies as outlined in the tables are (1) that there is an economic law operating in the make-up of a slum, and (2) that the underlying cause of slums is poverty. Back of poverty, of course, may be such personal factors as ignorance, incompetence, shiftlessness, and disease. This paper

TABLE II. PERCENTAGE OF COLORED FAMILIES IN THE SUBSTANDARD AREAS IN THE VARIOUS HOUSING INDEX CLASSIFICATIONS

Housing Groups	Areas*					Totals
	1	2	3	4	5	
1	12.3	29.6	56.3	65.7	60.34	28.4
2	30.4	59.0	92.5	88.0	68.96	64.8
3	26.7	58.4	94.3	85.0	84.37	68.5
4	24.1	64.0	85.7	92.7	95.45	78.8
5	80.0	89.9	96.7	96.2	98.14	96.2
Total	16.0	47.6	82.1	89.9	94.67	62.2

* For significance of area numbers, see legend on Fig. 1.

does not attempt to discuss housing subsidy from the standpoint of whether it adequately meets the underlying cause of slums in such a way as to effect a cure. If, as many claim, housing conditions are so bad that

FIG. 1. SUBSTANDARD HOUSING AREAS IN MEMPHIS
Blocks Classified According to Average Housing Conditions Under Which People Live in Each Block

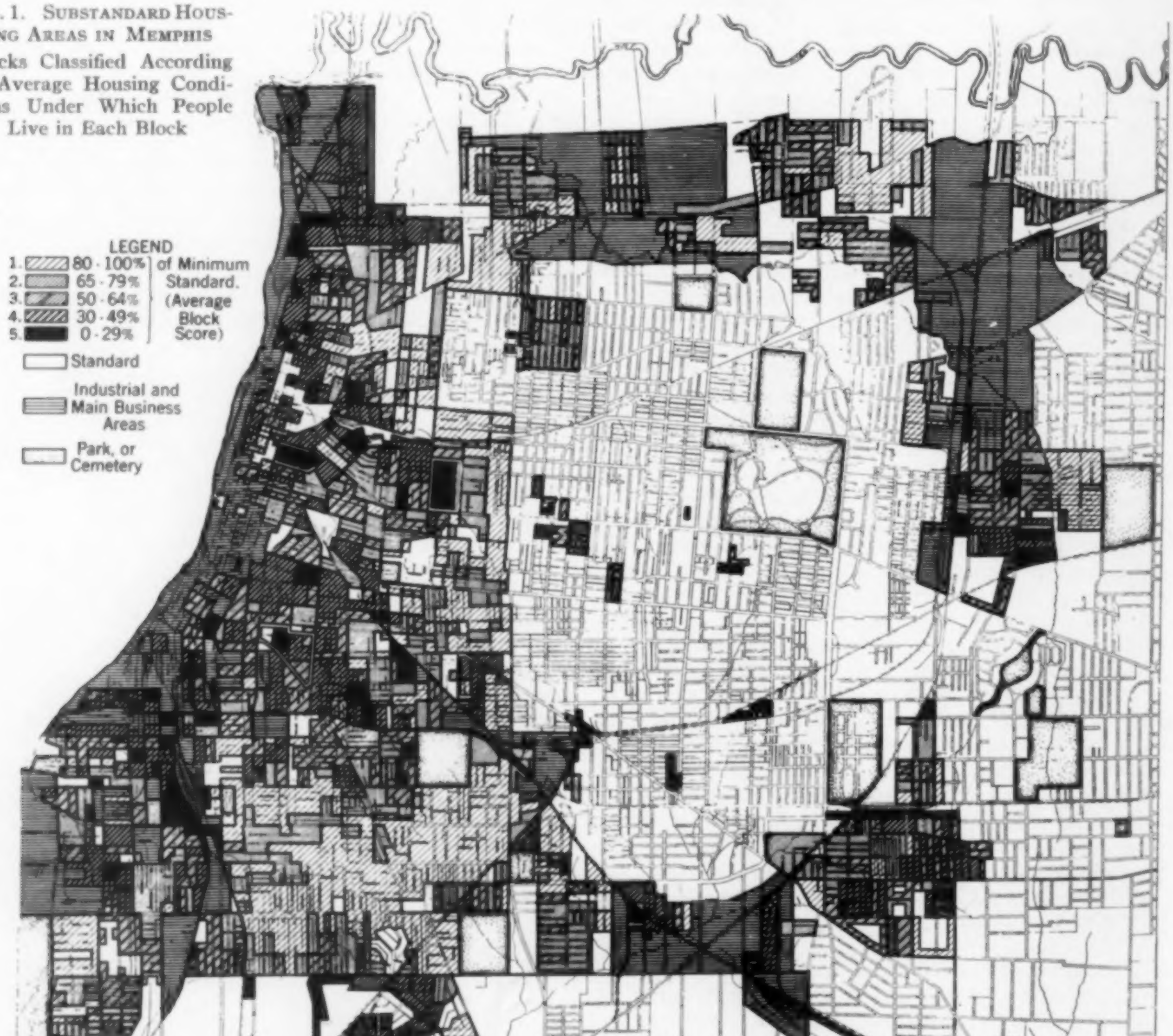


Table III. Percentage of Single-Family Living Units in the Substandard Areas

Housing Groups	Areas* 1	2	3	4	5	Totals
1	76.1	62.6	73.3	41.2	56.89	68.5
2	65.1	60.4	56.7	48.0	31.03	57.3
3	64.3	57.9	54.3	23.3	28.13	49.6
4	43.1	71.0	43.8	42.4	52.27	50.7
5	57.2	59.1	37.3	30.2	24.59	32.4
Total	73.3	62.6	52.6	33.7	28.91	52.3

* For significance of area numbers, see legend on Fig. 1.

something must be done immediately to improve them, then subsidy seems to be the first remedy that can be prescribed with some hope of quick relief. Selfishness, the overbearing burden of taxation, a shortage of cheap houses and of housing accommodations of all kinds, the lack of rapid and cheap transit, the lack of housing laws and enforcement of them, are all factors influencing the creation and extension of slums, but poverty is the underlying important cause that seems to offer an opportunity for immediate remedial action.

POPULATION DIVIDED INTO FOUR ECONOMIC GROUPS

Is it possible to develop a plan to provide some measure of housing relief for people of all levels of need, down to the lowest or poorest who need it the most?

If the population of Memphis were divided into four main groups according to income, each of these groups would present a different type of problem and solution:

1. *Well-to-Do Class.* At the top is a small percentage, possibly 15, who need no help or special encouragement or enforcement program. These people are able to buy or rent what they want and are reasonably well protected by subdivision restrictions and zoning regulations.

2. *Middle Class.* Below this 15 per cent is a group of approximately 32 per cent of the population who can rent good housing and even buy their own homes, some of them with the aid and encouragement of FHA and other easy-payment plans. People included in the middle class receive incomes of from $85 up to several hundred dollars a month, and should pay rents of from $16 to say $50 or $60 a month. No attempt is made to establish a definite dividing line between the middle class and the well-to-do class, and the percentages used in this paper for these two classes are of course arbitrary. Some of the first tenants in Lauderdale Courts—the first federal subsidized housing project built for white people in Memphis—came from the bottom of this middle class group. Twenty dollars a month was the average rent paid in the homes in which the new tenants in Lauderdale Courts lived before moving, and $94.10 a month was the average income.

3. *Marginal Class.* There is another group of approximately 26 per cent of the population of Memphis who live in standard or slightly below standard homes and areas, but who could be aided by a consistent, impartial, vigorous enforcement program. Most of the tenants in the first two federal subsidized housing projects came from the top portion of this class. This might be referred to as the marginal group. These people live in areas where rents vary from $12 to $16 a month, excluding utilities, and where incomes vary from $50 to $85 a month. These figures may seem low for a minimum-standard house, but the minimum standard as defined by the Memphis Health Department is low when compared to those of other housing agencies.

It is believed that the property owners of substandard houses in the blighted and twilight zones where the marginal group live, and which border the slum areas, would welcome a vigorous, impartial enforcement program that followed a definite plan for cleaning up these areas. A brief survey of the make-up of these areas indicates that possibly 2 to 5 per cent of the houses rate very low, and some of these are probably not worth repairing and should be demolished. Another 12 per cent possibly could be repaired, so as to bring the entire blighted and twilight areas up to a minimum standard with a minimum of enforcement work. The problem of enforcement, therefore, in the blighted or better sections of the substandard areas is a problem of improving somewhere between 2 and 17 per cent of the houses. It should be pointed out here, however, that this does not help the poor families, as they are forced to move into areas where the rents are low. Both the improvements required and houses torn down, automatically push poverty-stricken tenants out of this area either because their houses are gone or the rents are raised beyond their ability to pay.

4. *Slum Dwellers Class.* The fourth group, which constitutes the unsolved problem, is composed of those who live in the real slums of Memphis—at least 27 per cent of the entire population. Two factors are probably preeminent in causing so large a percentage of the population of Memphis to fall in this relief or slum dwellers group. One is the large negro population; the other is the high percentage of people brought up on the farm, who have moved into the city and are competing with city-bred people under handicaps which they have apparently been unable to overcome. In the slum areas over 40 per cent of the workers have come from farms, and in the very poorest areas this percentage is as high as 60. The inability of these people to overcome their handicaps is shown by the difference in income between them and those with city experience. In the entire substandard area, workers with farm experience average $37.25 per month, whereas those with city experience average $67.10 per month.

This slum group includes 76,000 people, mostly colored, who are not now included in any immediate plans for housing assistance. Their incomes vary from zero to $50 a month, and their rents vary from zero to $12 a month. This is frequently referred to as "the relief group who cannot be considered under the present subsidized housing program." Over 80 per cent of this group, which is 24 per cent of the entire population of Memphis, are members of families whose income is less than the income of families on relief as common laborers. (Some of the people actually on relief, making $57.12 and $74.80 as intermediates and skilled workers, are included in the third group (the marginal group), which could be provided with minimum-standard homes through an enforcement program.)

Table IV. Percentage of Living Units Owned by the Occupant in the Substandard Areas

Housing Groups	Areas* 1	2	3	4	5	Totals
1	36.8	28.5	32.6	18.7	17.24	31.9
2	23.2	16.2	15.8	21.3	6.90	17.7
3	17.8	17.3	22.9	8.3	6.25	16.6
4	15.5	19.3	10.0	13.1	5.68	12.9
5	11.4	5.6	7.5	7.2	4.29	6.2
Total	33.7	21.9	17.6	10.4	5.24	19.1

* For significance of area numbers, see legend on Fig. 1.

What, then, is to be done for the large so-called "relief" or slum group? The only answer possible at present is subsidy in some form. If $12 a month, exclusive of utilities, is required to maintain a minimum-standard house, then none of the 20,800 families who are slum dwellers can pay enough rent without subsidy to live in

such a home. A fundamental fact that should be kept in mind in planning a sound housing program which will eventually re-house slum dwellers is that the slum cannot be cleared or eliminated by simply rebuilding the dwellings.

SLUM CLEARING VS. SLUM SHIFTING

A slum may be defined as "a residential area occupied predominantly by poverty-stricken people living in housing which is so deteriorated, so substandard, or so unwholesome as to be a menace to the health, safety, morality, or welfare of the occupants and the adjacent community." This definition represents the slum not only as made up of wood, brick, and concrete, but as including the people who live there. Vacant houses if cleaned up and left vacant might at first thought still be considered a slum area, but most of the real objections to the slum would not exist unless these houses were occupied.

Slum clearance, then, should include not only the clearing or eliminating of the housing within the slum areas, but the provision of minimum standard housing conditions for this group or an equivalent group of slum dwellers. If this group of dwellers is not provided for, then the removal of the structures is not slum clearance, but slum shifting. This fact, it seems, should be obvious; yet it is elusive, and often forgotten in the treatment of the problem.

The underlying reason for the interest of health officials in the housing movement is the hope that the federally subsidized housing program will eventually include provisions for the poorest of the poor. If the cure of slums is subsidy and their cause is poverty, then unless the subsidy is for the poor, the cause of slums will continue and the slums will remain. Existing slums may be torn down, but wherever the poor go, the slums will follow.

COOPERATIVE PROGRAM OF SUBSIDY AND ENFORCEMENT DESIRABLE

A cooperative program, with publicly subsidized housing projects conducted for the lowest group and with enforcement agencies working on the top group of substandard dwellers (the marginal group), is most desirable. This plan would seem to be fundamentally sound and void of any chance of criticism by low-rent investment property owners on the grounds of unfair competition. The present efforts, however, are uncoördinated and not a part of a complete housing plan. Again I would emphasize: The entire substandard area must be considered in any complete housing program.

If, then, subsidized housing is the answer, what of the present subsidized housing program? This is the only housing program now under way that possibly can be converted or redirected into the field of housing for people on relief and below relief. It should be again emphasized that this relief group includes 27 per cent of the population of Memphis, and is the group on which statistics have been quoted and on which the federal program has

TABLE V. AVERAGE RENT PER MONTH PER FAMILY IN THE 25 HOUSING INDEX CLASSIFICATIONS

(All Figures in Dollars)

Housing Groups	Areas* 1	2	3	4	5	Total Monthly Rent Paid	Average Rent for Family
1	23.65	18.93	15.50	14.16	14.93	63,138	20.38
2	15.70	12.83	8.85	10.65	11.72	6,808	12.19
3	15.43	12.88	10.21	9.77	9.58	7,035	11.94
4	14.15	10.71	8.64	9.67	8.84	7,747	9.78
5	6.88	7.62	7.26	7.18	6.62	17,830	7.04
Total	22.04	15.21	10.41	8.91	7.48	102,559	13.46

* For significance of area numbers, see legend on Fig. 1.

been justified. Surely the subsidized housing program has not been intentionally developed under false pretenses. The real goal that should be kept in mind is a rent which the slum dwellers can pay, and not a rent which will support the project as designed and constructed.

The first attempt at federal subsidized housing under the PWA housing division in Memphis completely missed the mark so far as re-housing slum dwellers is concerned.

TABLE VI. AVERAGE INCOME PER MONTH OF FAMILIES IN THE 25 HOUSING INDEX CLASSIFICATIONS

(All Figures in Dollars)

Housing Groups	Areas* 1	2	3	4	5	Total Income	Average Income per Worker
1	105.52	83.24	64.04	54.96	56.96	360,840	88.25
2	68.48	51.90	37.66	40.12	44.34	39,385	49.95
3	73.26	61.40	37.07	45.35	40.86	42,925	52.35
4	66.45	48.52	34.25	37.46	37.82	44,968	40.60
5	37.61	33.92	30.08	32.53	31.55	113,321	31.90
Total	99.06	66.72	42.04	37.96	34.19	601,439	58.00

* For significance of area numbers, see legend on Fig. 1.

It is true that the projects serve as demonstrations of housing in Memphis and also stimulate the interest of the public in low-cost housing for slum dwellers. The 482 families, or 1,550 people, who were moved out when the Lauderdale Courts project was built were paying an average of \$6.70 per month rent and their incomes \$34.41; while of the families that moved into the project only two made less than \$50 a month. Again, in the "Dixie Homes," only one family was admitted that made less than \$50 a month, and less than 10 per cent of those admitted made less than \$60 a month.

The former rent paid by tenants who were selected for the Lauderdale Courts Federal Housing Project was almost three times that paid by the slum dwellers who were displaced to make way for the project. The rentals charged in the project, exclusive of utilities, varied from \$14.25 for 2-room apartments to \$23.29 for 5-room apartments. Eighty-seven thousand people in Memphis, a city of 300,000 population, were not eligible for occupancy in the project through the single requirement that the income of each family must be at least three times the rent. The average income of the tenants selected as meeting all the requirements for tenancy was \$30 a month more than the minimum income requirements just referred to as making 87,000 people ineligible for the project.

One important and promising saving in connection with large-scale housing projects is that made possible by the wholesale purchase of utilities. In the poorest areas the cost of utilities to an individual is, on an average, almost as much as the rent. The average rent in the Class 5 areas, which is \$7.48 per month, exceeds the average monthly cost of utilities by only \$1.35. This difference increases as the areas improve, until in the Class I areas, where the average rent is \$22.04 per month, the difference is approximately \$9.46. The cost of utilities for the three poorest classifications or areas averages in each case slightly more than \$6, while the cost of utilities in the Federal Project for a 3- and 4-room living unit will be somewhere in the neighborhood of \$3.

There is every reason to feel encouraged over the definite trend within the U. S. Housing Authority toward the building of housing units that can be maintained for lower rents. At present this is only a trend, however, and it must be encouraged and even insisted upon in order to eventually provide minimum-standard housing for the relief and below-relief, or slum, group.

Box-Girder Bridge at Yakima, Wash.

Adaptation of Transverse Diaphragms and Rollers to Narrow Skewed Piers Is Interesting Feature of New Structure

By O. E. Brashears

County Road Engineer, Yakima County, Yakima, Wash

Pleasing appearance and economy are combined in the new Terrace Heights Bridge, design and construction of which are described in this article. The handling of the skew problem, the sidewalk design, the arrangement of reinforcing bars, and the method of handling materials and forms, are all items of interest.

Another example of the concrete, box-girder type of bridge being built in increasing numbers along the Pacific Coast is the newly completed Terrace Heights Bridge at Yakima, Wash. It presents an interesting adaptation of transverse diaphragms and rollers to narrow skewed piers, and its entire 600-ft length of deck is devoid of expansion joints through the roadway. Instead of its main longitudinal reinforcing bars being localized in several closely packed layers at the top, or bottom, of the longitudinal webs of the box section, it has them distributed uniformly in a single layer, across the entire breadth of the tension slab. The contract price for this bridge, exclusive of the grading and paving of its approaches, was $74,373.50. Based on overall breadth, this amounts to $4.00 per sq ft for an H-15 bridge having a 24-ft roadway, two 3-ft 6-in. sidewalks, four 130-ft spans with 40-ft cantilever ends, and having all piers extending 15 ft below low-water level to bearing on firm compacted gravel.

The increasingly unsafe and unsatisfactory condition of the old bridge at this site had made the need for replacement apparent for several years, and when PWA funds were allocated for the purpose, Yakima County took immediate steps to build the new structure. Freedom from maintenance and upkeep made concrete the desirable material to use, while the low costs obtained elsewhere with box girders led to their adoption here where fairly long spans were wanted. The location of the highway was revised to correct errors of alinement, with the result that the new crossing is several hundred feet upstream from the old one.

A Core Form Being Lowered Into Final Position
Note Arrangement of Main Reinforcement in Bottom Slab

Transverse Diaphragms Staggered

As the new bridge comes at a bend in the river, the piers required skew placement to fit the current, and consequently were turned 20 deg from the normal position. In a box structure only 21 ft wide and with narrow piers, the familiar problems of offset bearings and warping stresses in the deck inherent in skew design are accentuated. However it was reasoned that in the concrete box-girder structure the roadway slab and the longitudinal webs bore the same relationship to one another as do the roadway slab and longitudinally extending steel beams and girders frequently used in steel structures; that the soffit slab was fairly flexible; that the inequality of deflections between squarely opposite points on adjoining longitudinal webs was indeed slight; and that if continuity between adjacent sections of the transverse diaphragms was prevented, adjustment of transverse warping deflections would be facilitated to the greatest possible extent. Therefore the diaphragms at the piers and intermediate points were offset, as shown in plan in Fig. 1. The behavior of the completed bridge indicates the sufficiency of this procedure.

A rigid-frame structure, with its horizontal thrusts at the footings and temperature stresses and expansion joints in the deck, was at no time considered suitable for this bridge. On the other hand, the continuous-girder deck, on rollers, with simple inexpensive treatment at the ends to allow for expansion, offered substantially all the advantages and none of the disadvantages of the rigid frame. The deck is made integral with the middle pier, but heavy steel-pipe rollers, concrete filled, permit longitudinal movement at the other four piers. Spaces allowing 2 in. of expansion at both ends of the bridge

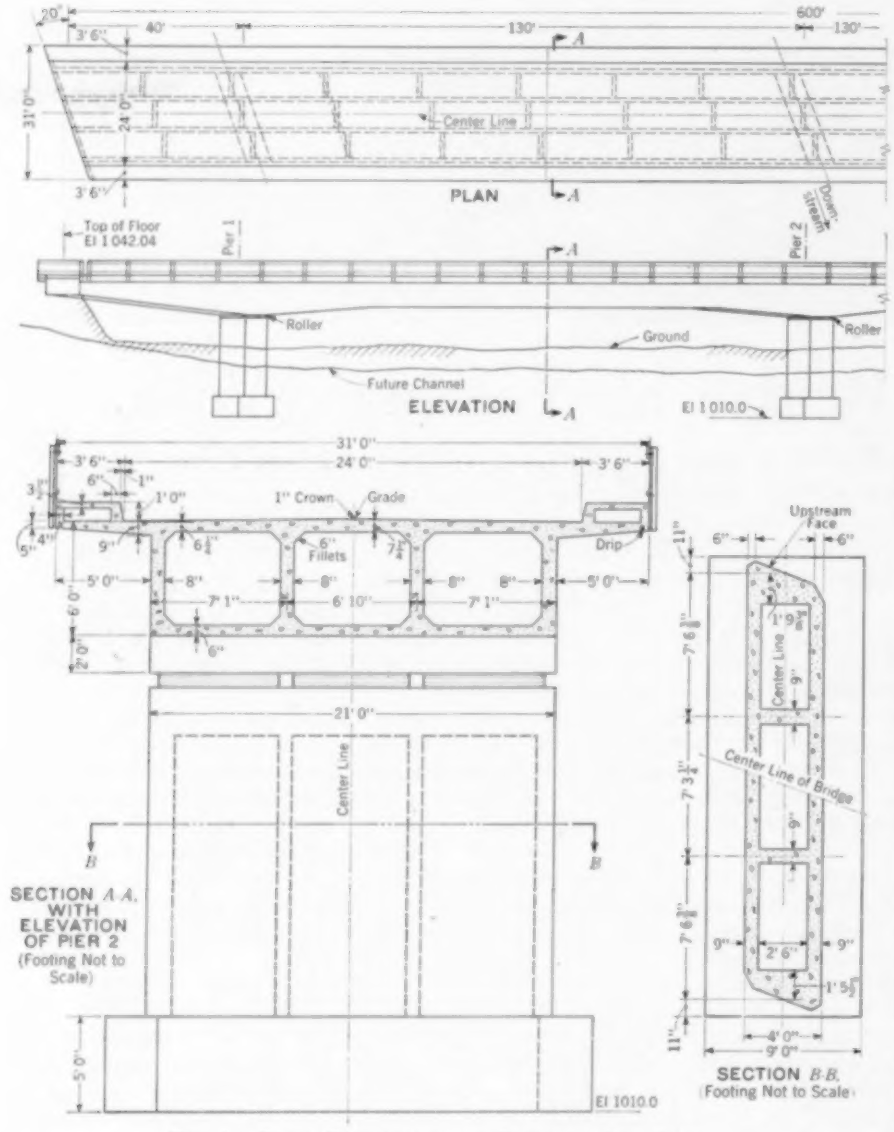


FIG. 1. PLAN, ELEVATION, AND SECTIONS, END SPAN
Other Three Spans Similar, Except That There Are No Rollers at Center Pier (Pier 3)

were obtained by holding back the upper part of the end embankments with small concrete baffle walls carried on concrete piles. It should be noted that these 2-in. end openings were provided not because any such amount of expansion was anticipated, but simply as minimum spaces from which forms could easily be removed. In fact, at the bottom of end walls the contractor made the openings somewhat wider than the 2-in. top dimension to further facilitate form removal.

The continuous-girder type of structure thus developed, permits of free expansion of the deck yet eliminates all joints from the roadway and sidewalks, assuredly a desirable condition. The roller joints themselves, largely sheltered from the weather by the box girder above and the projecting cantilever sidewalk slabs, were here left open and exposed on all sides, but they could easily be screened or enclosed if desired. With spans of this length and cantilever ends, dead-load stresses constitute over 80 per cent of the total due to dead, live, and impact loads, and it is principally in adjustment of unbalanced live-load and impact stresses, a relatively minor part of the whole, that slight advantages of stress distribution may accrue to the rigid-frame structure. In other respects—as regards joints, temperature stresses, and other factors—there are major advantages in the continuous girder.

The skewed piers are cellular, are 4 ft wide, and have a projected length of 21 ft, their ends terminating in the planes of the sides of the box girder above. Shells and crosswebs of the piers are 9 in. thick, and the pier ends are solid. The tops of the piers that support rollers are solid slabs 30 in. thick.

THREE ROLLERS REQUIRED FOR EACH PIER

Since rollers must be placed perpendicular to the direction of movement and must also have bearing, the conditions here necessitated not one roller but three per pier, disposed in echelon with a 2-ft 5-in. offset distance (Fig. 2). Directly above them in the box girder, sections of transverse diaphragm 14 in. thick and similarly staggered, transmit the loads brought to the pier by the four main longitudinal webs. The rollers are of 10-in., extra-strong pipe filled with a rich, dry mixture of hand-tamped concrete, and bear top and bottom on 1 by 12-in. steel plates anchored into the concrete. At the end piers, longitudinally extending shear lugs of concrete, on top of the pier and on the bottom of the girder, which slightly clear one another, resist transverse horizontal forces greater than the frictional resistance offered by the rollers in their length-wise direction.

Figure 1 shows the typical section and dimensions of the deck. The girder depth is 6 ft in the midspan section, increasing by straight flat haunches, 24 ft long, to an 8-ft depth for a distance of 4 ft at the piers. Except at the piers all transverse diaphragms are 6 in. thick. The longitudinal webs vary in thickness from 8 in. in the midspan panels to a maximum of 12 in. The bottom slab is 6 in. thick everywhere except in the panels adjoining the three middle piers, where it is gradually increased to a maximum of 9 in.

The roadway slab is cantilevered 5 ft on both sides of the box girder, and on top of these cantilevers hollow sidewalks are constructed with their core forms left permanently embedded in the concrete. While this

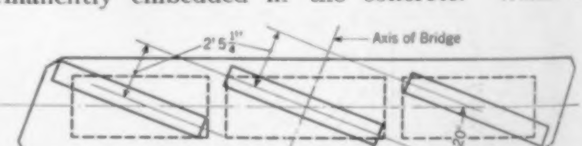


FIG. 2. SHOWING POSITION OF ROLLERS, PIERS 2 AND 4
Rollers on Piers 1 and 5 Are Shorter, to Make Room for Shear Blocks

arrangement entails a certain duplication of concrete, it has compensating advantages of simplicity in form work and reinforcement; it provides an under slab in the same horizontal plane as the roadway slab, and therefore to be used correspondingly as part of the box-

girder flange; and the construction for the curbs and sidewalks proper is made very easy, since they are built on top of the under slab in the final concreting operation after the falsework has been removed and deflections have occurred. Worthy of attention is the fact that the box section presents a maximum of flat surface to the weather, and from handrail to handrail has projecting corners only at the curbs and at the ends of the soffit slab.

Construction View from East End of Bridge After Removal of Core Forms

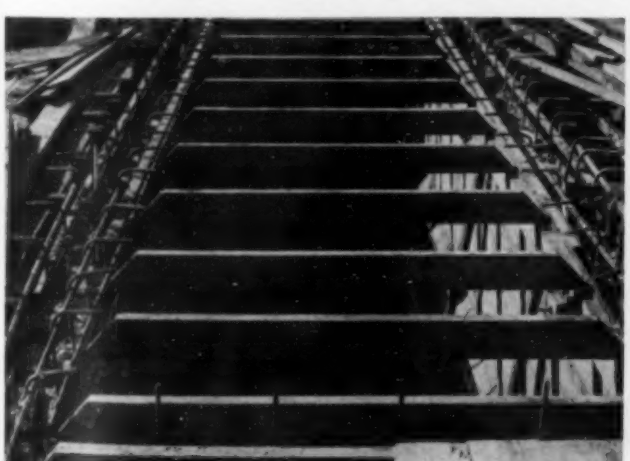
Deck-Slab Forms Have Been Placed Over Middle Cells and on Them Have Been Piled the Stringer Pieces for the Deck-Slab Forms of the Side Cells

In this bridge the main longitudinal reinforcement consists of a single layer of bars spaced uniformly throughout the full width of the tension slab, top or bottom. This arrangement greatly facilitated the placement not only of the reinforcement but of the concrete about it. One of the accompanying photographs is a view of the preliminary placement of the bottom steel in one of the spans before the middle row of core forms was set. It is to be noted that $^1/_2$-in. round slab bars 12 in. on centers extend beneath the main longitudinal bars, and their ends are turned up into the girder webs for 2 ft. These and the U-stirrups of the webs provide a wholly effective and satisfactory interconnection of flange and stems.

CABLEWAY USED IN CONSTRUCTION

For construction the contractor erected a cableway, drove piles for his falsework, and built his bottom form thereon. This form, 21 ft wide, continuous and unbroken from pier to pier, made an admirable working platform to which the cableway delivered reinforcement, core forms, and all construction materials. The core forms were made up on the bank at one end of the bridge in units which provided the completed inner forms—except for roadway slab—for the cellular space between adjacent longitudinal webs and adjacent transverse diaphragms. Only for 6-in. strips adjoining the web fillets were top forms used on the bottom slab. Elsewhere concrete was deposited directly into this slab through the open top and bottom of the core forms, and was spread and struck off to required thickness.

A Completed Core Form Before Placement



Stringers for Deck Slab Were Supported on the 1-In. Strips Bolted to the Webs

Ends of Stringers Were Cut to Form the Fillets at Top of Webs

Except at the ends of the bridge, the concrete was delivered by the cableway to hoppers whence it was distributed by buggies over movable plank runways. Bottom slabs and all webs up to the bottom of the top fillets were poured integrally and in runs approximately 130 ft in length, extending from center to center of adjoining spans. The core forms were subsequently removed, and only the forms for the under side of the roadway slab remained in place. The exterior sides of the girders, and of the piers above ground, were lined with plywood. Uniformly dense, sound concrete was obtained everywhere, except for some areas on the under side of the bottom slab of the cantilever at the west end, which seemingly lost the mortar from around the coarse aggregate particles to a slight depth—$^1/_4$ to $^1/_2$ in.

On removal of falsework the outer spans deflected $^7/_8$ in. and the inner spans deflected $^3/_8$ in., in approximate proportion to their dead-load moments.

Following are the principal items on which the contractor bid, and his unit bids thereon:

940 cu yd structural excavation	@ $5.00 per cu yd
1,180 cu yd Class A concrete (deck)	@ 27.50 per cu yd
157 cu yd Class B concrete (pier shafts)	@ 35.00 per cu yd
242 cu yd Class D concrete (footings)	@ 20.00 per cu yd
402,000 lb reinforcing steel	@ 0.05 per lb
1,200 lin ft handrail	@ 4.20 per lin ft

His total bid on the bridge was $74,373.50.

INDIVIDUALS AND ORGANIZATIONS PARTICIPATING

The bridge was constructed by Yakima County under the direction and supervision of the writer as county road engineer, and Loyd Fairbrook, assistant. The design and detailed plans were prepared by the W. H. Witt Company of Seattle. Homer M. Hadley, Assoc. M. Am. Soc. C.E., of the Portland Cement Association, furnished a number of suggestions regarding layout and other matters. Fiorito Brothers of Seattle were the contractors. The bridge and its approaches constituted PWA Project No. 1478F, and W. J. Stillmaker was resident engineer on the project for the Public Works Administration.

Disposal of Mixed Refuse by Sanitary Fill Method at San Francisco

By John J. Casey

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For the last seven years, San Francisco has been disposing of its mixed refuse by the sanitary fill method. First resorted to in emergency, the project has proved eminently successful. A carefully controlled technique is followed which prevents nuisances from developing, and not the least of the benefits of the operations has been the creation to date of some 60 acres of land that will ultimately be suitable for industrial use. This paper was on the program of the Sanitary Division at the 1939 Annual Convention of the Society.

During San Francisco's early history, garbage and refuse collection and disposal were done by independent scavengers who received but little official supervision. Food wastes were hauled to hog farms and all other refuse was disposed of in low-lying areas, where much of it was burned in open fires. Conditions generally were unsanitary.

In 1896, when the most available dumping places had been filled, the city granted to a private company, the Sanitary Reduction Works, a 50-year franchise to dispose of all the city refuse by incineration. A Thackeray Destructor, with a capacity of 300 tons daily, was erected the following year, and was operated continuously, under various owners, until 1932. For many years it was called upon to consume twice its rated capacity, with the result that smoking, half-cooked garbage was being loaded onto railroad cars and hauled to the dump.

By 1918, the city had purchased the destructor, and it was being operated by the Scavengers' Protective Union, which consisted of a majority of the collectors. By 1926, the property owners in the neighborhood brought suit against the city and the operators to obtain relief from the unpleasant conditions, and in 1929 the courts decided that the plant was a nuisance and should be replaced by a modern one. Although the city favored disposal by incineration, no progress was made towards the construction of an incinerator. In 1932, the court notified the city and the union that it would make permanent the injunction obtained by the property owners against the old plant, and gave all those interested 30 days to cease operations and adopt other methods of disposal.

Confronted with this emergency, Alfred J. Cleary, chief administrative officer of the City of San Francisco, decided to have the refuse hauled to tidelands, adjacent to the city, and covered with earth. The fill was started promptly by the Scavengers' Protective Union, and is now being operated under franchise by the Sanitary Fill Company, its successor. Seven years of operation have amply demonstrated the success of the method.

Six Hundred Tons of Refuse Collected and Disposed of per Day

The garbage and rubbish to be disposed of amounts to about six hundred tons per day. It is collected by private scavenger companies, licensed and regulated by city ordinance. No attempt is made to salvage articles that have a value as junk, except by the collectors themselves.

The loading platform to which the refuse is hauled is located between two spur tracks on railroad property at a central location. The structure is 380 ft long, 16 ft above track grade, and wide enough to allow trucks to maneuver so they can dump from either side into waiting trains. Aprons hinged to the platform are swung outward and rested on the cars to facilitate dumping and prevent spillage. Inclined approaches at both ends allow free truck movement at all times.

Sixty Acres of Made Land, Which Will Ultimately Be Suitable for Industrial Use, Are the Result of Seven Years of Sanitary Fill Refuse Disposal at San Francisco

The Telegraph Poles in the Middle Background Mark the Line from Which the Fill Has Been Extended. Mound and Rocks in Foreground Are at Bottom of Hill from Which Cover Material Is Being Taken

As each truck load of refuse arrives at the platform, it is weighed and dumped into the waiting cars. At this point, the Sanitary Fill Company assumes responsibility for the refuse. The scavengers pay the company for disposal, the maximum charge for which, fixed by ordinance, is $1 a ton.

The crew at the loading platform, employed by the Sanitary Fill Company, consists of 9 men, including a foreman and a night watchman. Their duties are to operate the aprons, trim the loads, place the wire covers over the top of the loaded cars, and clean up around the tracks. All loaded gondolas are hosed down to keep light material from blowing along the railroad right of way. The covers for the cars consist of heavy wire netting, mounted on metal frames and hinged to the top of the gondolas, 4 panels to a side. When the cars have been loaded, these covers are swung up over the top and chained together to keep them in place. The loaded cars are hauled to the sanitary fill in the early morning hours. The distance is about $4^1/_2$ miles, and the cost is $3.96 a car.

WIRE MESH COVERS ARE USED ON THE REFUSE CARS

EARLY DIFFICULTIES HAVE BEEN OVERCOME

In the first year or so of operation some difficulties were experienced. Roads over the fill were difficult to maintain during the rainy season. The refuse, which was at first dumped into shallow water at the shore line, was prevented from drifting into the bay by booms anchored at some distance from the edge of the dump; and as the face of the fill is exposed to storms approaching from the south over a long arm of the bay, the booms were difficult to maintain. Wave action against the toe of the new fill caused sections of it to break away or settle, exposing faces of fermenting garbage and causing cracks through which foul gases escaped.

UNLOADING AND SPREADING REFUSE

These difficulties were later overcome. A method has been developed for placing the refuse fill on mud, the load being so distributed that the layers of refuse and earth cover remain in their proper relative positions as they settle. The soft mud underneath is slowly squeezed forward, under the weight of the fill, and pushes up in a wave ahead of the filling operations, approximately to the elevation of high water.

The fill now extends southerly 2,500 ft from the shore line, at which operations were started in 1932, and extends easterly into the bay a uniform width of 1,050 ft. It is estimated that the refuse in the finished fill is approximately 50 ft in depth, of which about 25 ft is below the original mud surface.

When the fill was first started, ordinary spur tracks were constructed to the site, and refuse was unloaded from the cars onto trucks and hauled to the dump. As soon as the fill had progressed far enough, a balloon track was constructed. Today this track consists of two tangents, 850 ft apart, with a piece of curved track paralleling the outer end of the fill. The curved section is shifted at economic intervals, usually when the edge of the fill has been extended 250 to 350 ft beyond it—the maximum distance for bulldozing refuse efficiently.

HOW THE FILL IS SPREAD

Equipment used for unloading the cars consists of two dragline cranes mounted on crawlers, one 75-hp tractor, and one 60-hp tractor. Each crane unloads a 50-ft gondola car, the two cranes working simultaneously. As each pair of cars is unloaded, the train is moved ahead two car-lengths by a tractor. The cranes remain in the same position until the fill has been advanced 50 ft for a distance of approximately 75 ft along its face. The 75-hp tractor, equipped with an extra-large bulldozer blade, shoves the refuse to the edge of the fill; and the smaller tractor, with a standard blade, is used to trim the fill, spread the cover, and clean up. No garbage is left exposed at the close of the day, except on rare occasions.

When the fill has been advanced approximately 50 ft for its full width, the equipment is moved back to the starting point, and the operations just described are repeated, with some variations. Because the settlement of the fill is rapid and unequal, it must be raised repeatedly. The fill is first brought up to the track grade and then advanced. If sloughing is indicated by cracks or too rapid settlement, that portion is allowed to rest for a week or two, so that settlement will take place slowly.

As the fill is extended, it is also allowed to drop on a slight grade, which facilitates bulldozing operations. The next step is to bring the surface to the full height, so that after compaction it will assume approximately the desired grade. This is done by extending long "lifts" of refuse, about 25 ft wide, from near the track to within about 75 ft of the toe of the fill already placed. These long fills, placed side by side, increase in depth to 6 or 8 ft at the outer end, and are raised in 5 or 6 lifts, until the

A HILL IS GRADUALLY BEING LEVELED TO SUPPLY ROAD MATERIAL AND EARTH COVER
Note the Excellent Quality of the Road on the Fill

outer edge is brought to an elevation 10 or 12 ft above that of the track. (To accomplish this, it is necessary to bulldoze a certain amount of garbage uphill. This is the heaviest work the tractors do.) The track is then shifted to the edge of the fill, and the procedure just described is repeated.

It must be borne in mind that the fill is constantly settling. The first year the refuse is compacted to about 37 per cent of its volume when deposited loose. Each succeeding year, the subsidence is less. Considerable unequal settlement is noted, caused, no doubt, by soft spots in the mud bottom, or a variation in the depth of the mud. At times it is necessary to bring a depression to grade to maintain proper drainage. These depressions occur not only in portions of the new fill, but in areas that have been filled for two or three years.

ADJOINING HILL SUPPLIES COVER MATERIAL

Earth and rock for cover and road material are found in a hill adjoining the sanitary fill. It is necessary to use some powder, but very little hard rock is encountered. The material is excellent for covering garbage, and large bodies of rock are present which make good road surfacing material.

One shovel with a $1^1/_4$-cu yd dipper, and 4 dump trucks of 6-cu yd capacity, working on a 40-hour weekly schedule, cover the garbage and maintain the roads. The daily output is approximately 580 cu yd of earth, or approximately 1 cu yd of earth cover to each ton of refuse. The earth cover is used generously; therefore refuse is seldom exposed at the fill except when it is being unloaded.

Cracks develop in the earth cover near the edge of the fill as settlement takes place, but the equipment for spreading cover is always at hand and it is but a moment's work to fill it again. No cracks have ever developed in the finished fill inside of the balloon track. There is a force of 20 men employed on the fill, including night watchmen and mechanics in the machine shop.

Fires start occasionally near the outer edge of the fill, probably caused by spontaneous combustion, but these are quickly smothered with a blanket of earth, or even fresh garbage. On several occasions an odorless gas, probably methane, has seeped through the fill where the material used for cover was rocky, and has burned for several days, making no smoke or odor. The rock at the surface was badly burned. These fires were readily smothered with fine material.

There are no rats on the fill. At certain times flies are noticeable, but usually for only a few hours while the garbage is being unloaded, and only at certain times of the year.

In April of this year, two test pits were excavated in an area that had been filled 5 years before. The material removed consisted of 2 ft of earth cover, 2 ft of garbage, $1^1/_2$ ft of earth, and 6 in. of garbage. The temperature of the garbage did not exceed that of the surrounding earth. Newspapers, magazines, and can labels, when exposed, could be read clearly. Green peas, carrots, artichokes, orange peels, garden cuttings, and cloth had undergone practically no decomposition. Tin cans were so bright that reflections from them interfered with taking photographs of the excavated material. Practically no corrosion had taken place.

REFUSE AND GARBAGE REMOVED FROM SANITARY FILL AFTER FIVE YEARS HAD UNDERGONE PRACTICALLY NO DECOMPOSITION

COVER MATERIAL IS BROUGHT IN BY 6-YD DUMP TRUCKS, KEEPING PACE WITH THE BULLDOZING OPERATIONS

Nationalization of the Railroads?

A Desperate Remedy for a Desperate Disease

By William J. Wilgus
Honorary Member American Society of Civil Engineers
Ascutney, Vt.

NEARLY a third of the railroad mileage of the United States is in bankruptcy or receivership, says Colonel Wilgus, and another third is headed that way. Amalgamation of the lines appears to him to be the only solution of the problem, and of the two ways in which this might be brought about he favors nationalization. Following a concise analysis of present conditions and trends, he presents here rather detailed suggestions for putting such a plan into effect. That the remedy is desperate he willingly acknowledges—but adds, "A speedy major operation is in order to save the patient's life."

THE railroads of the United States in a physical sense are one; in their entirety they are as essential to the permanence of the Union as the Constitution itself. Over their closely interwoven lines the enormous rail traffic of the forty-eight states in all seasons is freely moved on joint through rates, in mass shipments of widely varying numbers, weights, and volumes, and by means of interchangeable equipment used in large part in common under uniform rules and regulations without break of bulk at connecting points.

But unhappily the railroads are not a unit in matters that lie at the root of their difficulties. Their several hundred separate ownerships, with independent managements, necessarily have divergent interests that run counter to the common good. Their differing density and character of traffic, and the innumerable variations in their working conditions, divide them into two classes—the financially weak and the financially strong. They do not pull together. They lack the federation that in a political sense has made our Union a success. Their house is thus divided against itself; none is his brother's keeper.

The consequences of this disunity are to be seen in much that the country in its extremity is facing today. Main lines and branches not earning their keep, though of importance to the public, are threatened with abandonment; others in financial straits, but still able to stagger along, are of necessity falling behind. Nearly a third of the total mileage is in bankruptcy or receivership and another third on the verge of a like fate. Of the 136 Class I railroads having an annual revenue in excess of $1,000,000, thirty-five in the first five months of 1939 spent more than they received. Even though the railroads as a whole should for a time weather the storm, the failing of the weaker ones, comprising two-thirds of the total mileage, must progressively drag down the others with consequent injury to the whole nation. Then there is the disastrous effect which the misfortunes of the weaker ones have on the communities they serve; on their investors, who are deprived of their savings; on their employees, who are thrown out of work; on dependent industries suffering from lack of orders; and on the nation's means of defense.

AMALGAMATION ESSENTIAL; TWO POSSIBLE METHODS

No cure for the railroad problem will be complete that does not provide for the healthy existence of the weaker roads, which are just as much needed in the public interest as the stronger ones. Tottering systems like the Chicago and Northwestern in the grain fields of the West, the Rutland Railroad and the New Haven's Old Colony and Ontario and Western roads in the East, and many others of lesser and even greater degree are as necessary to the people of the United States as the prosperous coal roads of West Virginia. It would seem quite obvious that the regional consolidation of the weak and strong into a multiplicity of large-sized groups, or a nation-wide unification, are the only ways in which their amalgamation can be brought about.

Of these two alternatives, regional consolidation at the hands of private agencies has been proved by bitter experience to be unattainable in the public interest. Unsuccessful attempts in that direction during the past generation under the terms of the Transportation Act of 1920, have been accompanied by exploitation, financial abuses, and worse. Moreover, the formation of a multiplicity of enlarged, independently owned groups of railways under private control would by no means result in the equalization of their financial strength which is so necessary for the good of all, any more than it has with the present smaller sized groups. Nor would it result in the settlement of rate disputes between regions and between local communities, or with rivals enjoying public largess, such as the highways, waterways, and airways. The other alternative—the speedy and scandal-free unification of all the railroads of the country under a single control—lies in government ownership under suitable safeguards, whether we like it or not.

Granting that this reasoning is sound, it remains to inquire if the unified system, in the light of past and present conditions, could be made self-supporting; how it might be brought into being; how it should be organized; and in what manner it could be made to work in harmony with its rivals in transportation.

FIRST STEP IN DEVELOPING A UNIFIED SYSTEM

In this undertaking the first step should be the making of a qualified survey to decide which of the main lines, branches, and terminals should be abandoned as having no commercial value and no place in the country's plans for national defense, and in other respects as not required in the public interest. Through the information thus gained, wasteful expenditures for the elimination of grade crossings on lines eventually to be taken up would be avoided, and economies would be made possible with due regard for the interests of the employees and communities affected. Facilities, too, would be retained that otherwise might later have to be restored at great expense for the movement of railway artillery, troops, and supplies to vital points in case of war.

The question simultaneously to be considered would be that of net income available for a return on the investment in the railroad system as a whole. As regards this the past has not been encouraging; what may be expected in the future under changed conditions? Since 1919 the railroads' proportion of the national income has

steadily fallen—from 6.6 per cent in that year to 5.6 per cent in 1929 and 3.8 per cent in 1938. They have not enjoyed a reward commensurate with that of other industries during prosperous years; and in lean years they have fared much worse. During the decline since 1929 their portion of the national income has fallen markedly below that of other industries as is shown in Table I.

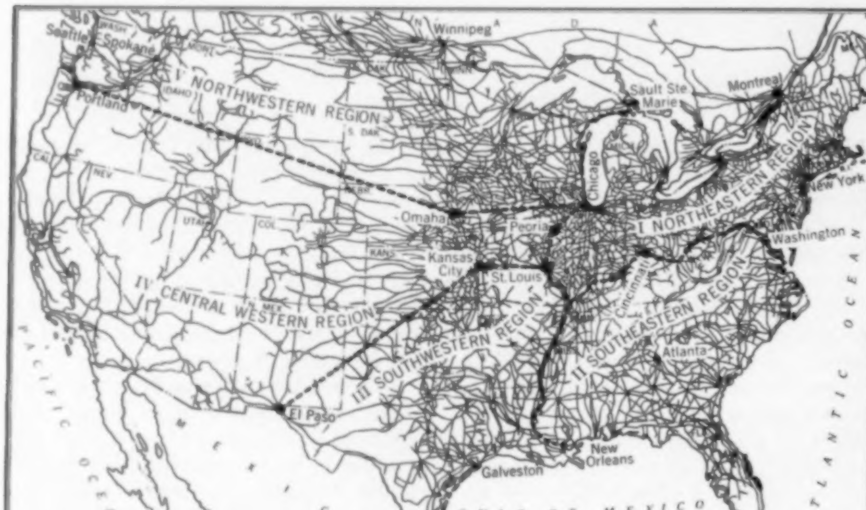

FIG. 1. RAILWAY NETWORK, SHOWING SUGGESTED REGIONAL PARTITION

TABLE I. ANNUAL INCOME, 1929–1938, FOR NATION, TRANSPORTATION AS A WHOLE, AND RAILROADS, ON BASIS OF 1929 AS 100 PER CENT*

Year	Total Nat'l Income from All Sources	All transportation	Transportation Other than Railroads, Pullman and Express	Railroads, Pullman and Express
1929	100.0	100.0	100.0	100.0
1930	83.6	86.5	92.9	83.2
1931	65.6	69.6	80.3	63.9
1932	48.5	51.1	62.7	44.9
1933	51.4	50.8	60.7	45.6
1934	61.2	53.8	64.8	47.9
1935	67.5	58.3	70.5	51.8
1936	78.9	67.6	81.7	60.1
1937	86.9	72.5	90.5	62.9
1938	77.4	62.1	80.4	52.5

* Based on information in letters from John L. Martin of Department of Commerce dated June 22 and 28; also in *National Income and Capital Formation 1919–1935* by Simon Kuznets, pages 63 and 67; also *Statistics of Railways in the United States*, Interstate Commerce Commision, years 1923 and 1937.

It will be noted that while the income of all transportation agencies fell off to a greater degree than that of the total national income, the income of the non-railroad agencies did better, and that of the railroads and their allies much worse.

TRENDS OF TRAFFIC AND OF FREIGHT RATES

The trends of railroad freight and passenger traffic, as compared with the trend of activities of the nation as a whole, have been distinctly downward during the past generation (see Table II). Unless it should be found possible in the future to stimulate rail movement through lessened rates and improvements in methods, there is little hope for a pronounced reversal in these trends, even with a restoration of prosperity, because of increasing competition from highways, waterways, airways, and pipe lines; the lessening demand for coal through economies in fuel consumption and the use of substitute fuels and hydroelectric power; and the decentralizing and relocation of industry seeking lowered costs of transportation through shorter hauls for both raw materials and finished products and through access to low-rate water routes. The falling off in the country's rate of population growth also must be borne in mind.

TABLE II. TRENDS OF NATIONAL INCOME AND FREIGHT AND PASSENGER TRAFFIC, IN PER CENT

Year	National Income	Freight Traffic		Passenger Traffic	
		Tons	Ton-Miles*	Passengers	Passenger-Miles*
1919	100	100	100	100	100
1929	140	119	123	65	67
1932	66	57	64	40	36
1937	120	90	99	41	53

* Increasing length of haul in the case of both freight and passenger traffic accounts for the slightly better showing in ton-miles and passenger-miles than in numbers of tons and passengers carried.

Admitting that the railroads as a whole have little reason for expecting a material increase in the volume of traffic under present rates, it will be asked if this may not be offset by a rise in rates. Here again it will be found that the tendency has been downward for the past 18 years, the freight revenue per ton-mile having fallen from 1.29 cents in 1921 to 0.95 cent in 1937, and the passenger-mile rate from 3.09 cents to 1.80 cents. It is difficult to see how it will be possible or advisable to increase them. On the contrary it is probable that they will continue to move downward. Especially is it to be noted that the present-day wholesale price index has not risen above its prewar level, whereas the average ton-mile rate for freight in 1937 was still 32 per cent above the corresponding rate in 1916. From this it is easy to understand why the producer (the shipper) energetically and persistently seeks for rival means of transportation in order that he may save as much as possible of his dwindling revenues. This is particularly true of goods for export which, with their long hauls in our wide territory, bear a total freight charge per ton—the real crux—that is greater than in many other countries where much shorter hauls though at higher rates per ton-mile prevail. This is brought out in Table III, the figures from which are, however, to be used with caution because of conditions that may not be strictly comparable. The railways there shown in all cases are government operated, except in Canada, France, and British India, where they are in

TABLE III. FREIGHT COSTS IN VARIOUS COUNTRIES*

Country	Date	Average Haul Miles	Average Revenue per Ton-Mile Cents	Average Revenue per Ton Dollars
Norway	6-30-1938	39	1.692	0.66
Japan	3-31-1937	109	0.674	0.73
Sweden	12-31-1937	103	1.312	1.35
Great Britain	12-31-1937	58	2.406	1.40
Denmark	3-31-1938	73	2.320	1.69
Germany	12-31-1937	100	2.160	2.16
France	12-31-1935	120	1.953	2.34
British India	12-31-1938	261	1.004	2.62
Australia	6-30-1937	122	2.185	2.67
United States	12-31-1937	337	0.945	3.18
Italy	6-30-1936	146	2.226	3.25
Canada	12-31-1937	327	0.997	3.26
Union of South Africa	3-31-1938	242	1.728	4.18

* Based on information in letter from Richard H. Johnson, Librarian, Bureau of Railway Economics, Association of American Railroads, dated March 27, 1939. In this, foreign moneys are converted to U. S. equivalents on basis of average exchange rates as reported by Federal Reserve Board.

both government and private hands, and in the United States and Great Britain, where they are altogether private. Although among the lowest in cost per ton-mile, the United States, which has the longest haul of all, is among the highest in cost per ton to the shipper.

There being no prospect of a notable growth in gross income from a larger volume of railroad traffic or from higher rates under the present order of affairs, it is natural to ask whether a reduction in operating expenses and taxes might be anticipated so that more could be saved for a return on the investment. Here again, as things are, there is not much to be expected. The average operating ratio has decreased from 85.7 per cent in 1919 to 74.9 per cent in 1937, a drop of 12.6 per cent, despite large increases in salaries and wages and costs of material. It is only through the lopping off of unnecessary non-profitable main lines and branches, the joint uses of terminals, the modernizing of equipment and other facilities, the abolition of "feather-bed" payments to employees, and the elimination of practices that force traffic into rival channels, that a further improvement in this respect is to be expected. To any considerable degree this is dependent on unification, with its elimination of wastes and injustices and its accompaniment of a sound credit on which to raise new money. As to taxes, we cannot look forward to a decrease as far as can be foretold.

Without the prospect of a pronounced increase in volume of traffic and rates and a decrease in expenses and taxes, the combined railroads of the nation, therefore, have little reason to expect that their combined net operating income will get back to that of the halcyon days of 1929, when it reached a peak of $1,263,000,000. The average for the past eight years, 1931–1938, inclusive, was a little less than $500,000,000, or say half the net for the year 1916 ($1,058,506,000), when the investment in road and equipment was but two-thirds its 1937 level of $25,636,000,000. While the investment has gone up some $8,000,000,000, or nearly 50 per cent, the net operating income has gone down 50 per cent.

Railroads "Falling into Decay"

For the first five months of the current year the net operating income for Class I roads is materially above what it was in 1938, but far less than in any of the preceding four years. Even with the addition of non-railroad income to their half-billion-dollar net railway operating income, and the making of various adjustments of income and outgo, the railroads as a whole under private ownership have barely, if at all, enough to meet their fixed obligations (See *Statistics of Railways in the United States*, Interstate Commerce Commission 1937, pp. s-78, s-82, and s-85). Two-thirds of them are in financial difficulties and their properties are not kept up. Without an ample cushion in the form of equities—venture capital—their credit is destroyed. And without a sound credit, the railroads, severally and collectively, are falling into decay of which the country too slowly is becoming aware.

The menace inherent in this decay becomes apparent when it is realized that between 1929 and 1937 the number and aggregate capacity of Class I railway equipment have fallen away to the extent of 23.4 per cent and 15.5 per cent, respectively, in steam locomotives; 23.5 and 18.6 per cent, respectively, in freight cars; 22.1 per cent in the number of passenger-train cars; and 18.1 per cent in the number of pieces of floating equipment. What is even worse, the obsolescence of the equipment remaining on hand has become intensified. Should the freight in the fall of 1939 approach that of 1937, it is estimated that there will be a shortage of more than 200,000 cars for handling the business. No manufacturing industry of magnitude could expect to succeed under such conditions, let alone one on which the country depends for the circulation of its life blood. It has been estimated that an annual expenditure of a billion dollars for several years

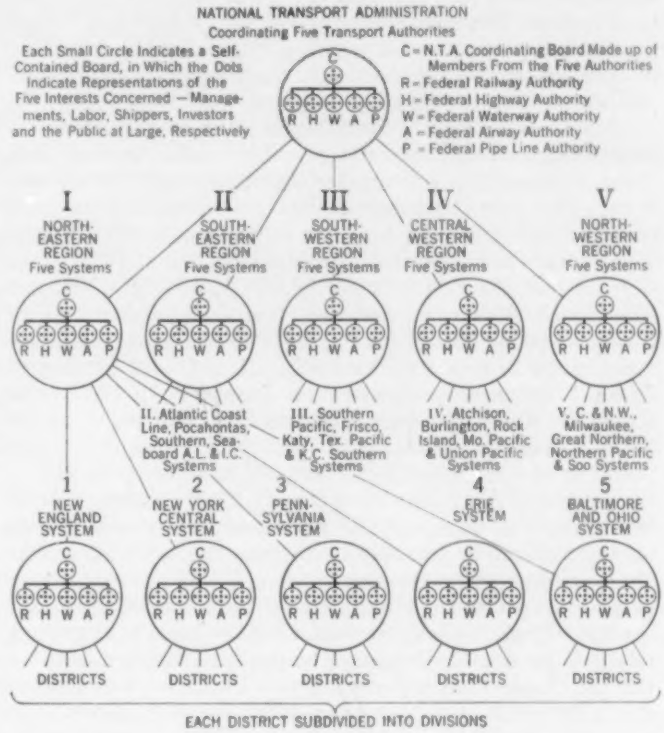

Fig. 2. Suggested Organization Chart for National Administration of Railroads and Other Means of Transportation

will be necessary for the rehabilitation and improvement of the railroads as a whole, in order that they may meet the needs of the public and get abreast of their competitors.

With their credit gone, or largely so, as instanced in the recent dropping of nearly $900,000,000 of their issues from the savings bank lists of New York State, the nation's railroads as a private institution are in no position adequately to serve the public and to make a profit, nor does their past record for nearly a quarter of a century give promise that they ever will be as of old. Such bills as have been introduced in Congress to put them on their feet have not gone to the roots of the problem. Regulation of diet will not save the patients from starvation if they lack sufficient food. Should the country have its hoped-for recrudescence of prosperity, or should war come upon us, the railroads' inability to carry the increased load would be disastrous.

If the reasoning here set forth is sound, the taking over of the railroads by the nation, and their unification through the agency of a "federal railway authority," would seem to be inescapable. It will be said that this is the policy of the defeatist lacking courage to "keep up the good fight." It will also be said that such a course spells socialism on a spreading scale, although that cry has not been raised in the pending public taking of the rapid transit facilities in New York City, or in connection with the activities of the Port of New York Authority. Another point that will be raised, and very properly, is that the dead hand of bureaucracy will kill the emulation and initiative that go with profit seeking.

One may ask in answer to this very natural opposition to nationalization, What else can be done? And if it is admitted that there is no alternative, should it not be conceded that the country must make the best of what many will consider a bad bargain and guide the drifting bark as far as possible toward safety? Otherwise, the writer believes, it will be on the rocks, with further ruin to investors, increasing unemployment, continued loss of purchasing power, and a growing failure by the railroads to measure up to the demands made upon them by the public.

That the federalized railroads could be made self-supporting seems entirely possible. The annual net railway operating income for the past eight years has averaged a little less than $500,000,000—say, 3 per cent on $16,600,000,000 or $2^1/_2$ per cent on $20,000,000,000. The total net capital outstanding in 1937 was $18,319,002,557, consisting of $7,068,862,752 in stock and $11,250,139,805 in unmatured funded debt (*Statistics of Railways in the United States*, Interstate Commerce Commission 1937, pages 46 and 58). The "final" value of Class I carriers' properties on January 1, 1937, was found by the Interstate Commerce Commission to be $19,972,000,000 (*Ibid*., p. s-76). The present market value is, of course, far less. Should it prove possible for the proposed Authority to exchange its securities on some fair basis for those of the railroads outstanding, with enough left over for rehabilitation, the unified system thus could stand on its own feet besides continuing to pay taxes as at present. Then, with the economies that have been mentioned, there is ground for the hope that enough net income would be earned to pay interest not only on the purchase price and cost of rehabilitation but also on the additional capital required for improvements. At least this does not appear to be an unduly rosy prospect when it is considered that it is based on the average of the actual earnings during eight years of the depression, coupled with an upturn estimated on the basis of the new conditions.

SUGGESTED PROCEDURE FOR NATIONALIZATION

In the belief that no time should be lost in meeting this situation head on, the suggestion is here made that Congress should enact legislation that would have for its objects:

1. The creation of a non-profit-making public corporation, to be termed, say, the Federal Railway Authority, with a cooperative board of 25 members, made up in equal numbers of representatives of the five interests involved—managements, employees, investors, shippers, and the public at large. The selection of the five members representing each interest would be made by the President from panels submitted to him by the national bodies most suitable for the purpose. One of the members of the board elected chairman would serve as the executive to carry out its policies. Cooperation would be the aim, with the interests of the public paramount.

2. The establishment of special courts for the determination of the fair value of the various railroads, as a basis for an exchange of their securities for those of the Authority.

3. The adoption of a nation-wide organization for administering and operating the railroads, under, say, five regional boards, constituted as in the case of the central board to which they would report; each such regional board to have jurisdiction over five system boards of a similar make up, and each of the latter boards to have jurisdiction over five district boards of a like nature (see Figs. 1 and 2). In this manner the policies of the central board would be generally observed; authority and responsibility would be properly delegated and decentralized; cooperation and efficiency would be fostered; and an esprit de corps would be created through promotions for merit.

4. The immediate taking over of the railroads by the Authority upon the working out of the nation-wide organization, first on a temporary rental basis, such as was adopted when they were taken over during the World War, and then as owner upon the completion of the valuations and the exchange of securities as mentioned. In this way delay in consummating the transfer from private to national control would be avoided.

5. A survey of the entire railroad situation with a view to deciding which of the railroad mileage properly should be abandoned; the extent to which the rehabilitation of roadbed, tracks, and equipment should be undertaken and improvements made; and the amount of money that should be appropriated for these purposes from proceeds of the sale of the Authority's securities.

6. A study of the rate fabric to determine what adjustments should be made to prevent dislocations of industry and regional injustices, to stimulate the interchange of persons and property between all parts of the country, and to foster foreign trade.

7. The making of special reports to the President and Congress with particular reference to improvements and rate adjustments requiring their action in the nation's interest; also monthly and annual reports of the kind now made by railroad companies to the Interstate Commerce Commission.

With the attainment of these objectives, and a realization of the benefits fairly to be expected, there would be no burden to be borne by the government for having taken over the railroads. Then if the abandonment of unnecessary lines and branches, and the rehabilitation and improvement of roadbed, tracks, and equipment, should result in considerable economies and increased traffic, it might become possible to effect a pronounced lowering in passenger and freight rates and a resulting further increase in the volume of traffic. Or it is possible that Congress, in its desire still further to reduce rates in the interest of the public at large and of foreign trade, might do as has been done in the case of highways, waterways, and airways—write off that portion of the railroad investment chargeable to right of way, channels of movement, and terminals. This, if done, would be in the expectation that the resulting increased burden of taxation would be more than offset by the country's quickened tempo.

In summing up it is to be said (1) that the disease from which the railroads are suffering cannot be cured by piecemeal attempts to bring relief to their constituent parts; (2) that of the two alternatives—regional consolidation and a nation-wide unification—the latter is the only one that can be effected with the required speed, integrity, unselfishness, and permanence; and (3) that unification, soundly planned as a cooperative enterprise and taken in time, should be free from the evils of favoritism and bureaucracy and should result in a quickened flow of traffic.

COORDINATION WITH OTHER TRANSPORT MEDIA

In solving the railroad problem, sight must not be lost of a similar need in the case of waterways, highways, airways, and pipe lines. They call for a solution along much the same lines—a central cooperative board with its subordinate boards—all five kinds of transportation to be brought together by means of coordinating boards on which they would have representation. The top coordinating board, to be known, say, as the National Transport Administration, and those beneath it, acting jointly in the interests of managements, employees, investors, shippers, and the public at large, would establish policies applicable to transportation as a whole, including the assignment of traffic to the means of movement for which it is best suited.

It will no doubt be said that the remedy here proposed is desperate indeed—and so it is. But so also is the disease. A speedy major operation is in order to save the patient's life. Perhaps another and worthier surgeon will point out a better way.

Air Raid Precautions: an Engineering Problem

Plans for Structural Protection Against Bombs, and Other Phases of Work of British "A.R.P."

By W. J. Quentin, Assoc. M. Am. Soc. C.E.

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Granting at the outset that no building can be made absolutely gas proof, and that it is impracticable to provide structural resistance against the effects of the heavier types of bombs, the British A.R.P. has concentrated on activities that will provide "relative" protection for vast numbers of people. Important phases of this work, as described here, include the preparing of specifications for underground shelters, for adapting existing buildings as shelters, and for construction of new buildings. It is of special interest that British plans for air raid precautions are the outgrowth of voluntary activities on the part of various engineering organizations—among them the Institution of Civil Engineers—and that since the establishment of the A.R.P. Department of the Home Office, a committee representing these organizations has continuously functioned in an advisory capacity. Major Quentin's article is abridged from a general study of civilian air raid precautions made for the Bureau of Yards and Docks, U. S. Navy.

Ordinances pertaining to air raid protection were promulgated in France and Germany in 1935. These regulations are mainly concerned with measures of collective protection against poison gases; structural methods are treated rather vaguely, and it is not known to what extent these ordinances have been enforced. The recent Japanese Air Defense ordinances of February 1939 are slightly more specific; they define such terms as "bullet-proof roofs and floors" and "defense doors," but on the whole their tenor is vague, and their enforcement is relegated to the local prefects. In England, on the other hand, the efforts towards devising and perfecting structural means of self-protection have grown to become a nation-wide movement, termed "A.R.P." (Air Raid Precautions). The very fact that A.R.P. is not the outcome of arbitrary government ordinances, but a step-by-step evolution, makes this movement an interesting object of study in connection with air raid protection in general.

ORIGIN AND DEVELOPMENT OF A.R.P.

During the critical period of September 1938, vast systems of trenches were built by the government in the public parks of London. Professional engineers, recognizing the inadequacy of these works from service experience during the World War, started discussions of this project in their professional societies, which in turn constituted themselves as joint agencies, submitting defense plans, and stressing the necessity of centralization of the control of air raid precautions. These sustained activities of the British engineering societies finally resulted in the establishment of the Air Raid Precautions Department of the Home Office, with an advisory committee representing the Institution of Civil Engineers, the Royal Institute of British Architects, the Institution of Structural Engineers, the Institute of Municipal and County Engineers, and others. Thus A.R.P. became definitely an engineering problem.

In some of its phases, A.R.P. is apparently only loosely connected with engineering. Emergency measures for reducing fire risk are mainly a matter of intensifying the precautions taken in ordinary times. Similarly, the handling of casualties through the stages of mobile first-aid parties, first-aid posts, and ambulance service to base hospitals has also more the character of an operational function. At first glance, the policy of evacuation may also be regarded as purely operational; but on closer analysis it becomes evident that the recent removal of hundreds of thousands of persons from London and other large cities presented a problem in traffic engineering of major importance.

Despite the evacuation, by far the greater part of the inhabitants of London will have to remain to "carry on." To provide suitable shelters for them is the principal task of the A.R.P. Department. Considering that protection against penetration of a medium-size high-explosive bomb is afforded by 15 ft of concrete, of which the upper 5 ft count as resistance against penetration proper and the remaining 10 ft against the results of the subsequent explosion, it was a task that at first seemed rather hopeless. However, in the light of study of the history of Barcelona during the recent air raids, the problem became less discouraging.

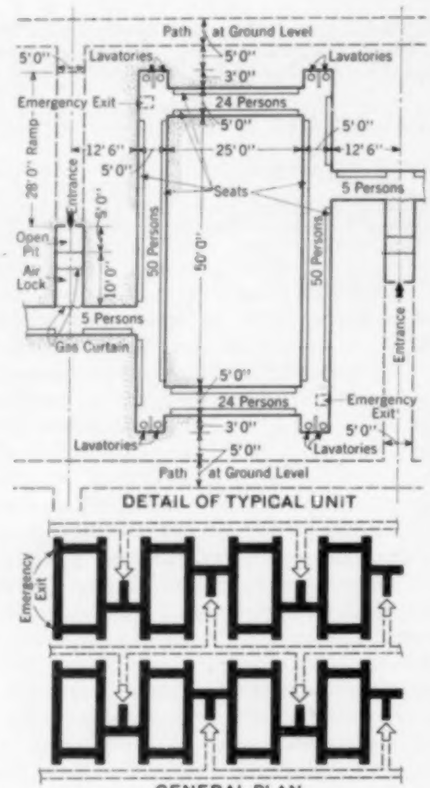
At the beginning of the air raids, Barcelona had a population of about $2^1/_2$ millions due to the influx of refugees—nearly double its ordinary number. Less than a year before its surrender, each air raid caused several hundred casualties, and at the end of the siege hardly any. During the latter period of the siege 455 high-explosive bombs, dropped in the course of five days and weighing from 10 to 250 lb each, resulted in only two persons being killed and 10 wounded, and nearly all these casualties were people engaged in voluntary ambulance work. No better proof could be expected of the relative efficacy of man-made shelters.

At the beginning of the siege nothing was done by the authorities to protect the inhabitants, and the latter very naturally followed the human tendency of seeking a "funk hole" in the ground. They found that an ordinary basement offered only poor shelter, but that by digging to a depth of 45 ft they were safe, deriving protection from the buildings, or their ruins, above. The next step was to establish communication galleries from house to house. Finally a system of galleries, with more or less refined revetment, was evolved for many city blocks, 45 ft or more below the ground. This defense system, originating in the crude attempts of civilians towards self-preservation, proved effective and convinced the government authorities that, with improved design, the construction of shelters could be facilitated, bringing collective protection into the range of practicability. Ultimately a sufficient number of mass shelters was available so that a person at no time was farther than 500 ft from the adit to some effective refuge.

These structures were of the cut-and-cover type, either entirely below ground, or partially so, several feet of the excavated earth being utilized to cover the

roof. A thickness of 3 ft of reinforced concrete over 4 ft of sand, over 5 ft of reinforced concrete, formed the conventional cross-section of the roof and, with several feet of the excavated earth over it, this structure was considered strong enough to afford effective protection against 660-lb bombs. This multilayer type of roof had proved its value in deep dugouts during the World War; the top layer of reinforced concrete acts as the detonator slab; the soft cushion of sand, gravel, or earth below serves to dissipate the energy of the explosion; and the lower slab of reinforced concrete resists the remaining destructive energy.

In view of the possibility of a panic, the floor plan was kept extremely simple and symmetrical. Entrances to the shelters were located on the sidewalks and had at least two right-angle turns in the ramp leading to the shelter below. Numerous exits were provided. The shelters were lighted from the city mains; auxiliary batteries were kept charged for emergency purposes. First-aid rooms, tool room, and lavatories were included in each unit; chemical closets were installed, since the shelters were too deep to drain into the sewer system. As the raiders did not use gas bombs, natural ventilation of the shelters was sufficient. The average allotment of space was $5^1/_4$ cu yd per person.



BLOCK SYSTEM OF TRENCH SHELTERS, DESIGNED TO ACCOMMODATE 1,200 PERSONS ON AN ACRE OF GROUND

The conclusions drawn from the effective protective measures in Barcelona have dispelled the formerly popular idea that air raids would make a shambles of a modern large city; they have proved, on the contrary, that even with a very moderate complement of anti-aircraft artillery, able only to protect vital centers, the life of a large city will not be severely disturbed by air raids provided the population can be furnished relatively secure refuge during the intermittent raids themselves.

However, the engineering committee of the A.R.P. Department is not prepared to adopt the Barcelona design in detail. It is true that A.R.P. has sponsored the construction of deep bomb-proof shelters under the buildings of some of the government departments and industrial concerns, but for various reasons it is opposed to deep air raid shelters for the mass of the population.

Recently a firm of constructional engineers exhibited a model in London, illustrating their scheme of constructing underground tubes 7 ft in diameter, lined with waterproof concrete, traced under the squares and main thoroughfares of the city. The A.R.P. committee estimates that for purposes of proper ventilation in presence of poison gas, a 12-ft tunnel would be the minimum size, and that the construction of 16 miles of such tunnel, as proposed by that firm of contractors, would require at least two years and would not accommodate more than 160,000 persons. Moreover, from a structural standpoint, deep shelters are not suitable in many parts of London, where the subsoil is mainly blue clay, overlain by quantities of water.

Under different geological conditions, and if designed for moderate magnitudes, deep shelters are no doubt suitable; they are, in fact, in the course of construction at numerous industrial plants. No uniformity of standard prevails. One shelter recently constructed by an industrial concern consists of a system of tunnels of an aggregate length of 1,000 yd and at an average depth below the surface of 55 ft. It affords complete immunity to 10,000 of the firm's employees. The work involved excavation of 18,000 tons of rock, lining the tunnels and installing equipment; and the construction schedule called for completion within ten weeks. The excavation is about 17 ft wide by 10 ft high. Inside is a lining of steel arches, giving a floor width of 16 ft 9 in. and a maximum height of 9 ft. The floor is concreted and the outside of the steel arches covered over with corrugated steel sheets. Access is provided through gently inclined tunnels; full occupation can be effected within a few minutes after an alarm. Ventilation is supplied by a series of holes extended by tubes to 18 ft above the ground, this height being considered sufficient to be clear of any surface concentration of gas.

The A.R.P. committee, in all its projects, favors the principle of dispersion, which implies that shelters shall be provided where the people live or work, or in close vicinity thereto, always avoiding undue concentrations. For this reason, for reasons of excessive expense, length of construction period, difficulty of gas-proofing, interference with gas and water mains, and impossibility of keeping locations secret from foreign observers, deep air raid shelters are not approved by the A.R.P. authorities. Tentative plans have been made by the Home Office for the construction of shelters of an average capacity of 50 persons only, each unit consisting of a gas lock, shelter chamber proper, and lavatory—with gas-tight joints for all openings. An air space of 106 cu ft is allotted to each occupant, reduced to 35 cu ft when artificial ventilation is provided. The suction vent for the fresh-air duct will be located from 9 to 16 ft above ground level; the incoming air will be filtered by passing through containers of chemicals. The air-supply system, when using artificial ventilation, is designed to furnish 0.7 to 1.06 cu ft per min for inactive occupants, and up to 3.5 cu ft per min for occupants who have to continue their occupations. Apparently these shelters have not passed the stage of research.

SUMMARY OF DEFINITE ACHIEVEMENTS

At the present stage [prior to the outbreak of war—Ed.], after an expenditure of about a hundred million dollars, the definite achievements of A.R.P. may be classified as follows:

1. Organization of A.R.P. service personnel.
2. Procurement of gas masks for the entire civilian population.
3. Instructions for adaptation of trenches as air raid shelters.
4. Issue of "tin-huts."
5. Instructions for construction of new buildings according to A.R.P. building code.

6. Instructions for adaptation of existing buildings as air raid shelters.

Of these, space will permit the discussion of only the last two in detail.

Considerations governing the adaptation of existing buildings and the construction of new ones are similar in many respects. From the earliest studies of these principles it became evident that A.R.P. specifications would always be governed by two definite limitations: First, no building can be made absolutely gas-proof; second, it is beyond the limits of practicability to provide structural resistance against the effects of the heavier types of bombs.

Actual tests demonstrated that a brick house, which had been made reasonably airtight, was penetrated by chlorine gas within seven minutes to such an intensity that the occupants had to put on their gas masks. Phosgene will be more effective than chlorine, and it must be expected that gas bombs will be dropped in conjunction with high explosive bombs—which will nullify most efforts towards air-tightening of houses. Gas masks will consequently be required for occupants even of improved buildings.

No such simple solution has been found for the second problem—the protection of buildings against heavy bombs. Only deep bomb-proof shelters afford protection against direct hits. A 22-in. reinforced-concrete roof slab of a building would resist a light high-explosive bomb weighing 25 lb, but would be pierced by any bomb heavier than that. The exterior walls of a house would have to be of reinforced concrete, 3 to 4 ft thick, to resist the blast and splinter effects of a 500-lb bomb bursting at a distance of 10 ft from the house, but they would be inadequate to resist the effects of the explosion of a heavier bomb weighing, say, 660 lb, not to mention the heaviest, of 2,000 lb or more.

CODE RECOMMENDATIONS FOR NEW BUILDINGS

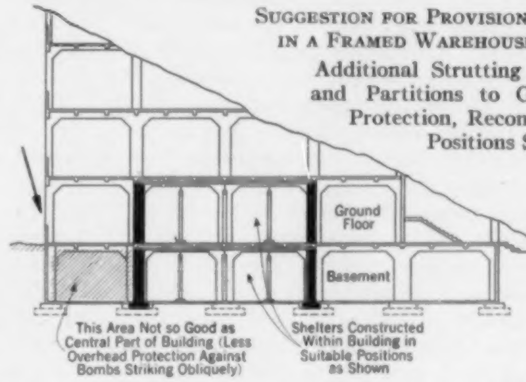
In order to stay within the limits of practicability, both from an economic and a structural standpoint, A.R.P. arrived at a compromise in specifying that roofs should provide resistance against direct hits by incendiary bombs, commonly weighing $2^1/_4$ lb, and that exterior walls should resist the blast and splinter effects of a common-purpose high-explosive bomb, weighing about 500 lb, bursting at a distance of 50 ft from the building.

Systematic tests have proved that roof slabs of reinforced concrete, $4^1/_2$ in. thick, will resist the direct hit of a $2^1/_4$-lb incendiary bomb, and that the explosive effects, other than from a direct hit, upon walls exerted by a 500-lb bomb bursting at 50 ft from a building are resisted by $1^1/_2$ in. of structural steel, or $13^1/_2$ in. of brick set in cement mortar, or 15 in. of plain concrete, or 12 in. of reinforced concrete, or a revetment of $2^1/_2$ ft of sand, or by a proportionate thickness of a combination of these materials.

On the basis of these considerations the A.R.P. building specifications intend:

1. To provide resistance against penetration by the smallest type of incendiary bomb;
2. To prevent and minimize the spread of fire caused by incendiary bombs;
3. To reduce the damage caused by the demolition of the upper part of buildings;
4. To prevent and minimize damage to buildings by 500-lb explosive bombs bursting at a distance of not less than 50 ft.

For preventing or minimizing the spread of fire caused by incendiary bombs, a roof slab of $4^1/_2$-in. reinforced concrete gives definite protection. A layer of sand 2 or 3 in. thick on weaker roofs will afford a fair degree of protection, probably exclusive of penetration. It is recommended that all combustible articles be removed



SUGGESTION FOR PROVISION OF SHELTERS IN A FRAMED WAREHOUSE BUILDING

Additional Strutting of Ceilings, and Partitions to Give Lateral Protection, Recommended in Positions Shown

from the upper floors of houses and that these floors be covered with a layer of sand.

To reduce damage caused by demolition of the upper part of buildings, a distinctive structural feature—the demolition slab—has been introduced. This slab is a heavy, strongly reinforced concrete floor, intended to sustain the dynamic and static loads occasioned by the collapse of floors above it in consequence of direct hits. It is recommended that the demolition slab for buildings of solid construction with thick interior walls, cross-walls, and partition walls be designed to carry loads of 200, 300, or 400 lb per sq ft, when there are, respectively, 2, 3, or 4 stories above the demolition floor. The demolition floor may be located over the basement, preferably not higher than the third story, and will serve to some extent as a detonation slab.

A departure from the conventional type of reinforced concrete floors is being studied. A higher steel ratio seems desirable, and instead of the zonal reinforcement by upper and lower rods, an additional system of vertical grid reinforcement of expanded metal is under consideration in order to improve the bond, which, according to tests, is the first cause of failure of reinforced concrete under the vibratory effect of explosions. The Japanese ordinances prescribe a distance of less than 6 in. between horizontal rods, with steel chords arranged zigzag in the upper and lower parts of slabs and welded to the main reinforcement.

In general, the design of all new buildings should embody the principles that will minimize destruction due to earthquakes; among other features this implies that exterior walls should not be load-bearing. Enclosed courts increase the effect of blast and should be avoided. All unnecessary protuberances (such as balconies) are also objectionable.

There are no principles of construction that will save windows. Plain glass windows will splinter under blast and are a definite hazard; wire netting inclosed in the panes will minimize, but not eliminate, this risk. Tests have been made with plywood replacing windows, and it was found that, although the plywood was not destroyed by an explosive blast, the window frame was blown out. To reduce the effect of splinters entering rooms through windows from outside, it is considered sound design to reduce the size of windows in general, to have the sill 6 ft above floor level, and to make the horizontal dimension of windows the larger one.

Beyond these specifications for thickness of roof, exterior walls, and demolition slab, and the general instructions regarding design, no definite standards

have been prescribed by the A.R.P. committee, since each building presents a special problem. Structures have actually been erected more or less in accordance with A.R.P. recommendations, and it appears that the cost for embodying these rules in the design of a new structure may be about 9 per cent of the total cost.

An important additional problem of A.R.P. is the maintenance of water supply for personal and industrial uses as well as for fire-fighting purposes. A full-size test, with typical London mains, subjected to the explosion of a 500-lb bomb, demonstrated that at a considerable distance from the point of explosion all nonferrous mains were shattered, cast-iron mains were breached locally only, and steel mains suffered damage at the joints in various places. The extent of the danger zone varies with the kind of pavement, the soil, and the depth of location of the pipe, and cannot be stated in definite terms. The vulnerability of the water system is fully recognized, and the localization of the effects of damage will be managed by an increase in the number of hydrants and valves.

The A.R.P. regulations and plans discussed in the preceding paragraphs do not make any provisions for that great portion of city dwellers who neither live in new houses, improved by A.R.P. building codes, nor in houses with sufficient area of yard or garden to qualify for tin-huts. In the original stages of protective planning for existing buildings, A.R.P. recommended a strengthening of the basement ceiling, with strong shoring, as in mining practice, to support the increased weight. This design was a makeshift, and the need for improvement on the basis of tests was obviously urgent in order to avoid the depressing psychological effect of the clumsy, unconventional structural members, which would have been a constant reminder of the ever-present danger of raids for the bulk of the population.

Use of sandbags on the outside of basement walls, in layers of $2^1/_2$-ft thickness, cannot be eliminated for the protection of brick walls of the thickness prevailing in London, and sandbags still form a handy means of covering basement windows, when overlapping the opening by 12 in. For interior protection, however, a standard design has now been produced, which avoids the objectionable features of the shoring previously recommended. This new design consists of corrugated steel plates which can be screwed to the ceiling joists and covered with fireproof plaster boarding, the whole being spray-painted to make a ceiling of almost normal appearance. Tubular steel supports will be provided and kept in store until an emergency, when they can be fixed in about 20 minutes; the steel bases on which they will be erected are adjustable by screws. These supports will be produced in varying lengths to suit basements of any height. This design has been tested in buildings subjected to actual explosions. Some types of houses will not be suitable for this type of protection, and in this case neighboring buildings that can be suitably reinforced will be selected as communal shelters. Until continued A.R.P. research work brings out further improvements, this type of reinforced basement and the tin-huts will constitute the shelter available to the great bulk of the people of London. The protection they afford is admittedly only relative.

A.R.P. HAS BEEN SCATHINGLY CRITICIZED

A.R.P. has been subjected to scathing criticism in its home country and has been charged with failure on the following counts:

1. With the exception of a comparatively small number of deep bomb-proof shelters, no complete overhead protection against direct hits by even small-sized high-explosive bombs has been evolved.

2. No lateral protection is afforded against blast and splinter effect from bombs heavier than 500 lb.

3. No effective structural protection against poison gases is provided.

A.R.P. admits that these charges are true and that it has only achieved "relative" protection for the population of London for these reasons:

1. The engineering project of sheltering six million people, who remain after $1^1/_2$ million have been evacuated, is a problem too immense to be solved in less than years of planning and construction.

2. It anticipated (correctly) an early emergency, and deemed it preferable to provide relative shelter for the majority, rather than complete security for a few.

An examination of these claims and counter-claims may be made from two standpoints—(*a*) that of plain engineering, and (*b*) that of national defense—as follows:

(*a*) Applying the principles of engineering, some critics have stated that the entire A.R.P. project works with a factor of safety less than unity. These engineers should remember that many a bridge or similar engineering structure, meticulously designed with generous "factors of safety," has failed because, as an entity, it had a safety factor less than unity when unforeseen or underestimated forces of destruction came into play. A.R.P. faces no such unforeseen forces; the experiments on the proving grounds have clearly outlined them in detail, and A.R.P. courageously propagates this knowledge to the public. Further, the engineer will realize the scope of a project postulating absolute overhead protection against direct hits, when he contemplates that all suburban houses, targets on which a raider would not waste ammunition, must receive heavy structural protection, not against the raider, but against descending fragments of shells of the anti-aircraft defense.

(*b*) Viewing the controversy as a problem of national defense, an analogy in another phase of the defense system might be pointed out. A battleship is fairly immune against 6-in. shells, but may be sunk by a few 12-in. shells, as most critics, contemporaries of the Battle of Jutland, must remember. Yet no sane person will advocate discontinuing the building of battleships on the basis of this argument.

EVALUATING THE CRITICS AND THE ORIGINATORS OF A.R.P.

On the whole, the detractors of A.R.P. are amateur military experts, or contractors eager for individual gain rather than conscious of public interest, or timid souls unwilling to assume the responsibility that national defense imposes upon every citizen. On the other hand, the originators of A.R.P., who by their voluntary efforts brought about the present degree of protection, are outstanding engineers, able to study and digest the lessons of proving-ground experiments and of the air raids of recent years. That these engineers, in the comparatively short period of their activities, have achieved concrete, if not wholly satisfactory, results, is admitted by their critics, and it may be anticipated that, with continued research work and with the steady increase of government support, they may eventually narrow the margin between relative and complete protection to such an extent that A.R.P. may be transliterated as "Air Raid Protection" rather than the modest "Air Raid Precautions," to which they now lay claim.

[Illustrations accompanying this article are from "Air Raid Shelters for Persons Working in Factories and Commercial Buildings," a pamphlet published by H.M. Stationery Office, London.]

Progress of Earthquake-Resistant Design

By Henry D. Dewell

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In recent years there has been much advance in that phase of structural design that has to do with making buildings earthquake resistant. Theory and research have been translated rapidly into practice, and the result has been to greatly increase the safety of structures in regions where quakes occur. Mr. Dewell here traces step by step the sixty-year development of modern concepts of seismic design, concluding with a summary of present knowledge. This paper was on the program of the Structural Division at the Society's 1939 Annual Convention.

It is only by reviewing the comparatively short history of seismology and seismic design that progress in this field can be adequately appreciated. Such a review may well be divided into four periods: (1) 1880 to 1906 (the date of the San Francisco earthquake); (2) 1906 to 1923 or 1925 (the dates, respectively, of the Tokyo and Santa Barbara earthquakes); (3) 1925 to 1933 (the year of the Long Beach earthquake); and (4) 1933 to the present time.

Certain names are preeminent in connection with the studies of the effect of earthquakes on structures made prior to the San Francisco earthquake. Perhaps the first is that of the great English scientist, John Milne, who was invited to Japan in 1875 by the Emperor to teach mining and geology and who in 1880 formed the Seismological Society of Japan. For 15 years thereafter he contributed much to our knowledge of earthquakes and their effect on structures, and it is to him we owe the invention and use of the shaking table for the study of earthquake effects. Other eminent seismologists of those early days were Seikei Sekiya and Fusechi Omori.

Some of the important conclusions of these early Japanese investigators were generally accepted without question by American engineers until about 1928, when the results obtained from more precise instruments and more extensive study began to cast doubt upon their validity. These conclusions, however, are worth recording as representing the first step in the study of earthquake-resistant design. They may be summarized as follows:

1. Structures should be made homogeneous as far as possible, with all parts firmly tied together.
2. An earthquake wave may be assumed, for purposes of study, to have a simple harmonic motion.
3. The destructive force of an earthquake may be measured by its acceleration, and the maximum acceleration of an earthquake may be estimated from the forces required to overturn stone lanterns and other objects.
4. The acceleration and amplitude of an earthquake and the damage done by an earthquake are much greater in alluvial soil than on firm ground.
5. The acceleration and amplitude of an earthquake are much greater at the surface of the ground than at an appreciable distance below the surface.
6. Short columns or piers having periods not greater than that of the earthquake suffer the greatest damage near the base, while tall structures, such as tall chimneys, behave as though the earthquake force acted impulsively at a center of percussion. Omori stated that his observations showed that tall, free-standing chimneys generally broke, not near their base, but at two-thirds of their height.
7. The period of a destructive earthquake varies from $^1/_2$ to $1^1/_2$ seconds.
8. The direction of maximum horizontal motion of an earthquake is normal to the line joining the station of observation with the epicenter of the earthquake, and the greatest movement is due to transverse vibrations.

In California the interest of engineers in earthquake-resistant design may be said to have begun with the great San Francisco earthquake of 1906. A committee of the San Francisco Association of Members of the American Society of Civil Engineers, the forerunner of the San Francisco Section of the Society, made an extensive study of this earthquake and its effects. The committee's comprehensive report was published in the Transactions of the Society (Vol. 59, 1907), and their conclusions were reflected in the structural design of buildings for many years thereafter. It is to be remembered that in 1906 reinforced concrete was in its infancy, that reinforced concrete buildings were not allowed in San Francisco, and that there were but few in the adjacent cities.

Developments After the San Francisco Quake

Abstracts from the report of this committee are here recorded as indicating the second definite progressive step in earthquake-resistant design:

1. "Sufficient evidence is at hand to warrant the statement that a building designed with a proper system of bracing to withstand wind and a pressure of 30 lb per sq ft will resist safely the stresses caused by shock of an intensity equal to that of the recent earthquake."
2. "The prime requisite of the structure is elasticity. To this requirement the building with a timber or steel frame answers very well. The reinforced concrete structure does also with exceptions. The building of stone, brick, or block construction, having mortar joints, does not answer the requirement at all."
3. "Foundations did not suffer at all. . . . The evidence is that foundations well built along accepted lines are adequate."
4. "It may be questioned whether difference in workmanship was not responsible for many of the results. While it is true that good workmanship gives better results than ordinary, it is still the opinion of the writers that it was mainly a question of design."
5. "A brick spandrel wall adds little if any to the bracing of a steel frame."
6. "All evidence in the recent shock favors reinforced concrete, but the writers are of the opinion that the steel frame offers the best solution of the problem."
7. "Some discussion has taken place as to the advisability of making a monolithic mass under the buildings. Several of these have been constructed. . . . They are all of relatively small base. Buildings of 12 stories and a base of 150 ft with isolated pier foundations suffered no more than similar buildings with monolithic bases."
8. "The writers reiterate the statement that speaking generally, buildings of brick walls and wooden interiors cannot be built which will not be wrecked in a severe shock, it being a fault of design and not of materials or workmanship."

The first conclusion relative to the equivalence of a wind force has now been discredited, and the author of the statement regrets the publicity that has been given to it, but the remainder of the conclusions are still regarded as essentially sound.

After the San Francisco earthquake, for a period of 18 years, until the Tokyo earthquake of 1923, progress was substantially at a standstill. Engineers considered that buildings had proper earthquake resistance if they had strong, structural-steel frames with wind girders,

HOTEL BUILDING WRECKED IN THE SANTA BARBARA QUAKE (1925) Showing Effect of Absence of Anchorage Between Floor Joist and Masonry Walls

gusset-plate connections in the wall spandrels, and somewhat heavier than standard connections in the interior, provided the masonry, brick, or reinforced concrete walls were well anchored to the structural frame. The most important advance was the fact that members and their connections were planned with the thought that they would have to resist earthquake shock, although as yet no building ordinance mentioned earthquake. In the revision of the San Francisco building ordinance, made immediately after the earthquake, construction to resist earthquakes was provided only by subterfuge, such as high value of wind pressure and minimum sizes of structural members, limitations on dimensions of walls, etc. Earthquakes were not to be publicly mentioned. The fundamental principles embodied in the design of buildings during this period have not yet been discredited and are today generally considered to be among the essentials of seismic design.

TOKYO QUAKE USHERS IN THIRD PERIOD

The period from the great Tokyo-Yokohama earthquake, which occurred on September 1, 1923, until the Long Beach earthquake on March 10, 1933, is the third step in our history. The interest of American engineers was immediately awakened by the Tokyo disaster because for the first time modern buildings of structural steel and reinforced concrete had been subjected to the forces of a destructive earthquake. A number of American engineers visited Tokyo and Yokohama and published their impressions and conclusions. The Society appointed a special committee of American and Japanese engineers to report on the damage and the lessons to be learned.

While the committee was still engaged in this work, the Santa Barbara earthquake of June 29, 1925, occurred and the interest of American structural engineers was intensified. The scope of the committee work was immediately enlarged, and the title of the committee was appropriately changed to Special Committee on the Effects of Earthquakes on Engineering Structures. In its report the committee endeavored to present, not only the factual knowledge of the effect of earthquakes on structures, but also the latest thought on seismic design.

The committee's attention was directed to the textbook of Dr. Tachu Naito, entitled *Earthquake-Proof Construction*, which was published just before the Tokyo earthquake. Its merits were immediately recognized and a translation of the entire text was made and included in the report.

Naito's work has had a profound influence on structural design in California and elsewhere. He was the first, in so far as the writer knows, to make practical use of the principle that a horizontal force on a building with stiff floors is distributed among the structural elements of the building in proportion to their relative rigidities and not in proportion to wall areas or column spacing, or at the convenience of the designer. He first set forth practical methods of determining the relative rigidities of walls, partitions, and structural frames, and pointed out that shearing deformations in walls were more important than flexural deformations. He also realized the importance of a symmetrical arrangement of resisting units. The principle that the centroid of the resisting units of a building must coincide with the centroid of mass of the building, if dangerous torsional moments due to earthquake are to be avoided, was developed later by California engineers. These fundamental principles are as applicable to design for wind as for earthquake, and have been accepted by California engineers as correct structural practice.

One interesting feature of the committee's work was the measurement of the natural vibration periods of a number of tall office buildings in San Francisco, made in 1927 by Dr. Perry Byerly, seismologist of the University of California. From this small beginning came the extensive program of measurements made by the U. S. Coast and Geodetic Survey.

FLEXIBILITY VS. RIGIDITY

During this period two schools of thought developed on the seismic design of buildings. One held to the principle of rigidity combined with strength as the essential factor; the other held that sufficient strength and rigidity were difficult to attain, were unnecessarily expensive, and that flexibility was not only an essential but also reduced the amount of strength necessary to resist earthquake shock. A special case of flexible design, known as the flexible first story, was advocated. Essentially the theory was that the first story of a multistoried building should be made so flexible in relation to the stiffness of the stories above that the earthquake motion would be there absorbed; that such small damage as would occur would be confined to the first story and that consequently no special construction to resist earthquake need be incorporated in the upper stories. The tacit assumption was made that the structural frame would act as if independent of the walls and partitions, whereas in practice the first story structural frames were in part or in whole built into massive masonry walls or stiff reinforced concrete walls, so that they were incapable of functioning as designed. Today's conception of the flexible first-story building is very different from that of twelve years ago. It is now recognized that the first story of an office building is usually more flexible than the upper stories and that this flexibility does materially lessen, but does not eliminate the effect of earthquake on the upper stories.

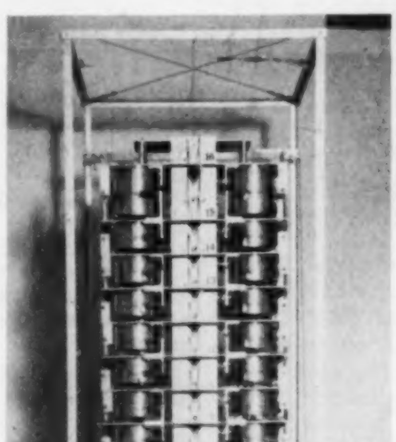
At the World Engineering Congress held in Tokyo in 1929, the seismic design and construction of buildings was the major subject of discussion. American engineers attending this Congress found the Japanese theoretical and experimental work, subsidized by the government, so much in advance of similar work in America

that they accepted the conclusions of the Japanese as the best thought of the day. The majority of Japanese engineers were in favor of rigid buildings, as perhaps was natural in view of the height limit of 100 ft in Japan, which makes this type of construction entirely practicable. Rigid buildings, designed to withstand acceleration of from $^1/_{20}$ to $^1/_{10}$ of gravity with normal working stresses, had survived the great 1923 earthquake without appreciable damage; and in general the degree of earthquake damage appeared to have been greater in those buildings with greater periods of vibration. Consequently, the Japanese engineers concluded that buildings not exceeding 100 ft in height with periods not exceeding $^6/_{10}$ second, of proper strength, were capable of withstanding, without appreciable damage, an earthquake shock comparable to that of 1923. Contrary to Omori's conclusion that tall chimneys tend to break at about two-thirds their height, Japanese engineers as a result of a survey concluded that these structures might break at any point in their height and that the acceleration in the upper part might be from 50 to 100 per cent greater than the acceleration of the ground.

In the years following the Tokyo disaster, the well-known Japanese engineer, the late Kyoji Suyehiro, as well as Tachu Naito, made notable contributions to our knowledge of earthquake-resistant design. During these years also, Prof. R. R. Martel, M. Am. Soc. C.E., at the California Institute of Technology, was using a small shaking table to investigate the action of elemental forms of structures such as rectangular frames, subjected to vibration, and correlating these experimental studies with theoretical analyses. His work represented then the only American experimental research in seismic design.

The Santa Barbara earthquake resulted in an increase in earthquake insurance rates and a requirement on the part of financial houses that earthquake insurance be a prerequisite to any loans for important new construction. Business groups in San Francisco and Los Angeles were aroused by these requirements, viewing them as possible limitations to new construction, and as a direct result a new standard building code was begun which would take cognizance of earthquake risk. This building code, then, known as the Uniform Building Code—California Edition, was sponsored by the California Development Association, the forerunner of the present California State Chamber of Commerce, and was written by technical committees appointed by the national engineering, architectural, and contracting societies, in conjunction with the Pacific Coast Building Officials Conference. After nearly 13 years of work, this code—now known as the Building Code for California—has just been published.

Another direct result of the interest in earthquake-resistant design was the inauguration of the Vibration Research Laboratory at Stanford University in 1926 through the efforts of Dr. Bailey Willis, with Lydik S. Jacobsen, professor of mechanical and civil engineering, in direct charge. A large shaking table, 9 ft by 12 ft, was constructed for use in these investigations; later other facilities were installed.



Model Used to Study Earthquake Effects on a 16-Story Building

About this time it was realized that horizontal torsional moments could be taken care of by application of the principle that all vertical structural elements resist torsional moments in proportion to the square of their distances from the centroid of resistance, and also in proportion to their rigidities.

In the fall of 1930, in connection with a study by a commission of the earthquake resistance of a 20-story building proposed for San Francisco, Jacobsen constructed a model of the building and subjected it to various assumed earthquake motions. New and valuable information was gained from these tests, and since then similar and more extensive tests have been made on other models.

Many Developments Since 1933

The Long Beach earthquake of March 10, 1933, marks the beginning of the latest step in our history of progress. Long Beach contained many modern office buildings with frames of structural steel and reinforced concrete and consequently it afforded an excellent opportunity for study of the effects of an earthquake on modern buildings.

Great damage to schools, particularly those of brick construction, disclosed the generally very poor quality of construction. Public sentiment was aroused to such an extent that the State Legislature passed the Field Act, placing the construction and reconstruction of all school buildngs under the control and direction of the State Division of Architecture, which was instructed to draw up suitable rules and regulations governing this construction. The Division of Architecture naturally and wisely adopted almost in total the engineering portion of the Uniform Building Code—California Edition, calling it "Appendix A" of its rules and regulations. The name "Appendix A" has continued and has become almost a byword to California engineers and architects.

At the same time the legislature, recognizing the need for state-wide protection of buildings, passed the Riley Act, under which it is required that, excepting farm buildings and like structures, all buildings shall be designed and constructed to withstand a lateral force of 2 per cent of the vertical load, or a wind pressure of 20 lb per sq ft.

The defective workmanship exposed by the Long Beach earthquake created a profound impression throughout the state. The necessity for careful, honest construction and competent inspection was for the first time generally understood by the public. The result has been that good construction has been demanded and obtained. Also, for the first time realization has come that the engineer must be made responsible for both the design and supervision of construction of structures, if protection against earthquakes is to be attained. These are the most important advances in building construction in California in recent years.

As a result of the enactment of the Field Bill, there resulted an extensive program of strengthening old schools and building new schools throughout

California in accordance with the strict regulations of the State Division of Architecture. These regulations require that buildings three stories or less in height which have no moment-resisting frame shall be designed and constructed to resist a lateral force of from 6 to 10 per cent of gravity and that buildings over three stories in height, having a moment-resisting frame, shall be designed to resist a force of from 2 to 6 per cent of gravity. The next major California earthquake will find many buildings with definite computed resistance, and there will be much valuable information available to engineers.

VICTIM OF THE LONG BEACH EARTHQUAKE (1933)—A SCHOOL BUILDING WITH BRICK MASONRY WALLS, TIMBER INTERIOR, AND HEAVY ORNAMENTATION

The strong motion program of the U.S. Coast and Geodetic Survey, begun in 1931, was much increased in scope and was renamed the California Seismological Program. Accelerographs, displacement meters, and seismographs were installed at strategic points throughout California and in other Western states, and periods of both natural and forced vibrations were determined for buildings, bridge piers, water tanks, and dams. To date 1,200 observations have been made on 400 buildings, 150 on 41 tanks, and 200 on special structures. In this work a portable ground and building shaker was developed at Stanford University by Jacobsen, and many of the observations have been made with this machine on buildings, dams, and bridges. Some 500 tests have also been made of ground vibrations.

A special study of the damage done to Class C masonry buildings by the Long Beach earthquake was made under the supervision of Martel, in addition to his continued experiments with the shaking table. At Stanford University Jacobsen has continued and extended his studies of the effects of vibrations on models of buildings and of dams and reservoirs.

At the Massachusetts Institute of Technology, Arthur C. Ruge, Assoc. M. Am. Soc. C.E., Assistant Professor of Engineering Seismology, has studied both theoretically and experimentally, by means of models subjected to vibrations, the earthquake resistance of elevated water tanks. Ruge has concluded that the statical method of design against earthquakes cannot be applied safely to elevated tank structures. Expressed in more general terms, his studies indicate that a method of design found applicable to a special type of structure cannot be safely used in general design.

In the six years since the Long Beach earthquake there has been great advance in the studies and investigations of earthquake design, particularly in experimental investigation. Some of the old theories and ideas have been discarded in the light of advanced study. There are yet many unknowns to be evaluated, and it may be that we shall never evaluate all of them. Although it would sometimes seem that the earthquake is not bound by physical laws, the vibrations it sets up in buildings are in general not limitless and their values may be approximately evaluated. Structural engineers are still in disagreement regarding the forces to be resisted and the detailed methods of design. But even though we may not be able to evaluate accurately the forces of an earthquake, we can, through experimental studies of models subjected to dynamic loads simulating earthquake action, determine systems of static shears which will give reasonable designs sufficiently strong to resist earthquake shocks of those intensities likely to occur. It is felt that much greater progress will be made in this way than by theoretical investigation alone, although theoretical studies must always supplement the experimental work.

"WHAT WE THINK WE KNOW TODAY"

In conclusion it may be of interest to summarize what we think we know today about earthquake-resistant construction. The following statements are believed to summarize our present knowledge, principally in connection with buildings, since most of our studies, investigations, and experience have been in this field:

1. Foundations should be secure against settlement in an earthquake and all the following statements assume stability of foundations.

2. The ground characteristics of the general area are of great importance in evaluating the probable earthquake forces on a structure. There are indications that different areas may have different characteristic periods of vibration.

3. In buildings with floors sufficiently stiff to act as distributing plates, the distribution of lateral force to the various structural elements is in proportion to their rigidities. The walls of a building furnish the major resistance; measurements indicate that they may be ten times as effective as the steel frame. Consequently the exterior walls, as well as stiff interior walls, should be given strengths commensurate with their rigidities, and the floors should be given strengths to act in accordance with their stiffness in horizontal planes.

4. All vertical structural elements resist torsional moments in proportion to the square of their distances from the centroid of resistance, and also in proportion to their rigidities.

5. The centroid of resistance of the vertical structural elements should coincide with the centroid of mass of the building, or else the resulting torsional moment must be provided for.

6. Some New Zealand tests on models of walls, with and without openings, subjected to horizontal forces at their tops and in the plane of the walls, give deflections in reasonable agreement with theory, thus indicating that current methods for determining the relative rigidities of walls are substantially correct.

7. Buildings not over 100 ft in height and with a height not greater than twice their least base dimension may be designed as rigid structures for a lateral force of $^1/_{10}$ of gravity using ordinary working stresses with reasonable assurance of no earthquake damage. With increased working stresses, say, as high as $1^1/_3$ times the usual working stresses, the damage will probably be minor.

8. For all buildings, including those of multi-storied type, shear distortions are of much more importance than flexural distortions.

9. Beside the fundamental period of vibration, the second and third modes may affect the structure, although to a lesser degree. The fundamental period is the most important.

10. Increase in flexibility of the basement story, or the first story, results in decreased dynamic shears in the stories above, and offers a possible method of earthquake design.

11. Vibration experiments with models of buildings with structural steel frames and brick masonry walls, and from 16 to 29 stories in height, justify the tentative conclusions that tall office buildings must be regarded as flexible rather than rigid structures and that they should be designed for dynamic shears. It appears that this horizontal shear varies from story to story. Considering only the fundamental period of the building, the story shears may be assumed to increase from $^1/_{20}$ of gravity in the first story to $^1/_7$ of gravity in the top story, the mass in each case being taken as that above the story in question.

Application of these statements to structures other than buildings must be made with judgment and caution.

Kutter's *n* in Trinity River Floodway

Field Study at Dallas, Tex., Supplies Useful Data on Overbank Flow

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BOTH the technique and the results of a study of overbank flow in the artificial channel of the Trinity River at Dallas, Tex., are reported in the accompanying paper. With a flow of 77,000 cu ft per sec, values of Kutter's "n" were determined in each of five reaches of the floodway, which is 2,000 to 3,000 ft in width and more than seven miles long. Also observed was the loss of head that occurred through each of nine bridges crossing the main floodway channel.

SINCE the completion of the Trinity River levees at Dallas, Tex., in 1930, no flood taxing the works to capacity has occurred. That of May 20, 1935, however, came about halfway up on the levees and afforded a good opportunity to study the flow of water in a floodway of considerable size. The present account is the first to be released of that investigation. It is concerned primarily with the determination of the value of *n* in the Kutter formula, but touches also on the head loss caused by the various structures that cross the floodway.

The Dallas Levee Improvement District lies wholly within the flood plains of the Trinity River and its Elm and West forks; but the new floodway between the levees, except in a few places, lies outside the old river channel (Fig. 1). The new floodway, which was completed in 1930, lies between two levees, which vary in height from 25 to 40 ft. Approximately in the center of the floodway there was constructed a pilot channel to carry the low-water flow. The levees at the lower end are parallel and 2,000 ft apart, thereby reducing the flood plain to less than half its original width at that point. They extend in a northwesterly direction from the Santa Fe Railroad tracks, at the lower end of the floodway, to a point north of the Texas and Pacific Railroad. Thence they turn gradually until they are running almost due west. The floodway also widens gradually around this bend to a width of 3,000 ft. It crosses the old West Fork River channel $2^1/_2$ miles above the Texas and Pacific Railroad, then extends west approximately 2 miles farther to the new forks.

At the new forks, as will be noted in Fig. 1, the West Levee makes a bend to the left and extends southwesterly to the hill line on the east side of the West Fork flood plain. The East Levee also turns at the forks and extends in a northerly direction to the opposite hill line.

By this construction the flood plain was reduced from approximately 3 miles in width, in places, to a floodway 2,000 to 3,000 ft in width, thereby reclaiming 10,000 acres of land that had formerly been subject to overflow.

Design Values of Kutter's *n*

The floodway was originally designed to carry a flow of 500,000 cu ft per sec. Kutter's formula was used in the design, and the floodway was assumed to be divided into three separate sections with values of *n* for each as follows:

Pilot channel	0.030
Borrow pits	0.035
Floodway	0.045

The floodway was originally cleared of all trees, stumps, brush, and even tall weeds, but large sections of it have since been overgrown with brush and small willows. As shown in Fig. 2, the most heavily overgrown areas are between the Commerce Street and the Texas and Pacific viaducts and in the section of the floodway surrounding the old West Fork channel crossing. There is also a heavy overgrowth of brush and willows about midway between the two above mentioned. Perhaps the cleanest stretch of the entire floodway is the upper end from the old West Fork channel crossing west to the new forks.

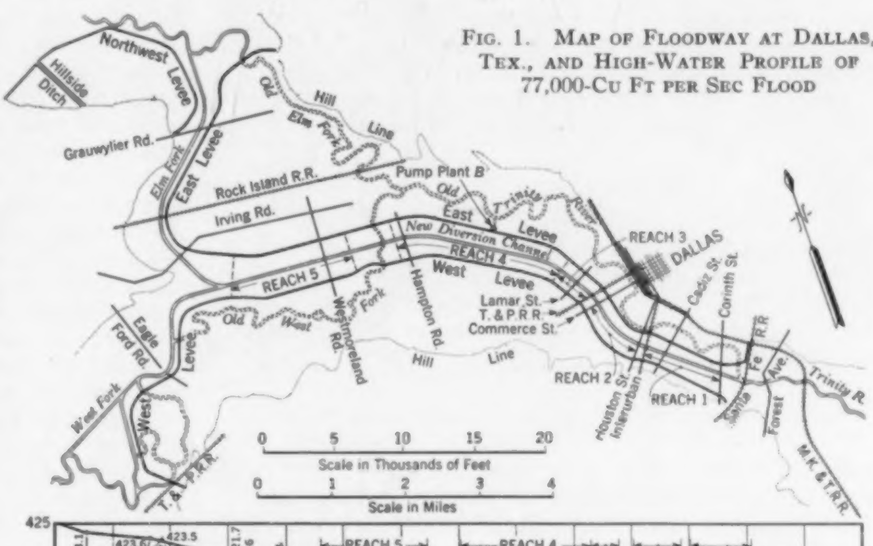


Fig. 1. Map of Floodway at Dallas, Tex., and High-Water Profile of 77,000-Cu Ft per Sec Flood

PILOT CHANNEL JUST AFTER COMPLETION, AND (AT RIGHT) FOUR YEARS LATER. NOTE HOW CHANNEL HAS WIDENED AND WASHED BACK INTO SPOIL BANKS

This section has a very few scattered willows and is fairly clear of tall weeds.

PRESENT CONDITION OF FLOODWAY

The pilot channel in the floodway has widened to several times its original width and some of the spoil banks have been completely washed away. Figure 3 shows several channel cross-sections, as they existed at the time of the study, compared with the originally excavated sections. The present cross-section of the channel is fairly regular and erosion has occurred about equally on both sides. There are very few obstructions along its banks, such as trees, brush, or weeds; and it thus affords a free flow of water up to its high banks. The levee borrow pits, on the other hand, have been partially filled with silt, and in many places have been partially covered by a growth of small willows from 10 to 15 ft in height.

From the forks of the new floodway to the lower end there are seven viaducts extending from levee to levee

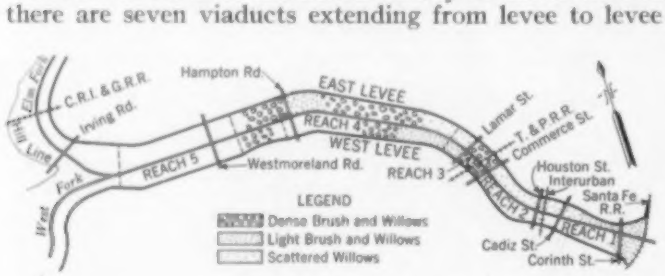


FIG. 2. DENSITY OF SECOND-GROWTH BRUSH AND WILLOWS

and two roads leading down from the levees, with steel Pratt-truss bridges across the channel. All but one of these viaducts were built after the levees were constructed and have streamlined piers. The remaining one, the Houston Street viaduct, is a concrete arch structure which spans the total width of the original flood plain. Figure 4 shows details of the Texas and Pacific Railroad and the Commerce Street viaducts which cross the floodway of the Trinity River, and of the Chicago, Rock Island and Gulf Railroad bridge which crosses the Elm Fork floodway approximately a mile above the new forks.

HOW FLOOD DATA WERE OBTAINED

The discharge of the flood of May 20, 1935, measured by the U. S. Geological Survey, Water Resources Branch, at its gaging station at the Commerce Street viaduct, was found to be a little over 77,000 cu ft per sec. During the peak of the flood, which lasted approximately five hours, several parties were sent out to establish temporary high-water marks at various points along the East and West levees. (It should be noted that in the 6 hours preceding the peak the stage rose but 0.3 ft.) These high-water marks were set by driving stakes to the high-water level on the levee bank and at most places were located 100 ft downstream and 100 ft upstream from the various viaducts and road crossings. High-water marks were also set at various places for a distance of approximately 25 miles above the levee district and 3 miles below it. The high-water marks through the floodway were set with the utmost care, although in some places there was found to be a surge of the water surface of as much as 0.1 ft. In such cases an average was taken as close as possible.

After the flood waters had receded, elevations were taken of all these high-water marks and also of other natural high-water marks, such as fine silt lines, where they could be found. The latter were used only as a check on the stakes that had been set and in practically all cases the agreement was very close. Figure 1 shows the profile of the high water throughout the floodway.

Distances between the high-water marks were measured along the channel, the points of measurement being the points of intersection with the channel of lines drawn through the high-water marks and perpendicular to the floodway. The elevations of the high-water marks were recorded to hundredths of a foot, but because of the method that had to be used in setting the stakes, it was

TABLE I. DETERMINATION OF ENERGY SLOPE FOR EACH REACH
(For Q = 77,000 Cu Ft per Sec)

Reach	Elements at Upper End of Reach					Length of Reach, L	Elements at Lower End of Reach					Energy Slope S	Water-Surface Slope, s
	A_1	V_1	h_1	Z_1	E_1		A_2	V_2	h_2	Z_2	E_2		
1	29,560	2.60	0.1	409.4	409.5	5,550	29,400	2.62	0.1	408.3	408.4	0.000198	0.000198
2	32,250	2.39	0.1	410.6	410.7	4,300	28,270	2.72	0.1	409.7	409.8	0.000209	0.000209
3	28,410	2.71	0.1	411.7	411.8	2,750	28,370	2.71	0.1	411.0	411.1	0.000255	0.000255
4	23,360	3.30	0.2	415.5	415.7	11,200	30,650	2.51	0.1	411.7	411.8	0.000348	0.000339
5	30,170	2.55	0.1	419.0	419.1	8,950	31,900	2.41	0.1	416.7	416.8	0.000257	0.000257

NOTE: Z = elevation of water surface; h = velocity head; E = elevation of point on energy line = $Z + h$; h_f = friction loss = $E_1 - E_2$; L = length of reach; S = slope of energy line = h_f/L; s = slope of water surface; A = area in sq ft; V = velocity in ft per sec.

decided that they were accurate only to the nearest tenth; therefore, they were used only to the nearest tenth in the calculations.

Cross-sections of the floodway used in the computations (Fig. 5) had been taken several years before the flood, but had changed very little except in the channel itself. These sections were located approximately every 1,000 ft along the center line of the floodway. Cross-sections of the pilot channel (like those of Fig. 3) had been taken in 1934 by the Corps of Engineers of the U. S. Army, and between that time and May 20, 1935, there had been no flood sufficient to make any material difference in the cross-sectional area of the channel. These river cross-sections were superimposed on the original floodway cross-sections to calculate the total cross-sectional area. Because of gravel pits in certain sections of the floodway and natural irregularities in the ground, the cross-sectional areas show considerable variations.

The wetted perimeter of each section was taken as the distance from edge of water to edge of water on the two levees, plus twice the total depth of water, plus twice the depth from natural ground to the bottom of each borrow pit. Because of the change in floodway width from 2,000 to 3,000 ft, there is also a great change in the wetted perimeter, which varies from 1,946 ft at one section in the 2,000-ft floodway to a maximum of 2,993 ft in the 3,000-ft floodway. Since the wetted perimeter and the corresponding areas of the cross-sections did not vary proportionally, there was found to be quite a large variation in the hydraulic radius of the various sections.

FORMULA FOR KUTTER'S n

The primary purpose of this study was to determine the value of n in Kutter's formula:

$$n = \sqrt{\frac{e\sqrt{R}}{BC} + \frac{1}{4}\left(\frac{C-B}{BC}\right)^2 R} - \frac{1}{2}\left(\frac{C-B}{BC}\right)\sqrt{R}$$

in which $e = 1.811$

$B = k + \dfrac{m}{S}$, where $k = 41.66$ and $m = 0.00281$

S = energy gradient of reach

$C = \dfrac{Q}{A\sqrt{RS}}$

Q = discharge through floodway = 77,000 cu ft per sec

A = weighted average cross-sectional area of reach

R = weighted average hydraulic radius of reach

The floodway was first divided into five reaches as shown in Fig. 1. Reach No. 1 begins approximately 2,800 ft from the lower end of the floodway and extends to a point 100 ft below the Dallas Interurban viaduct, a length of 5,550 ft. Reach No. 2 begins 100 ft above the Houston Street viaduct and extends to a point 100 ft below the Commerce Street viaduct, a total length of 4,300 ft. Reach No. 3 begins at a point 100 ft above the Texas and Pacific Railroad viaduct and extends to the upper end of the 2,000-ft floodway, a total length of 2,750 ft. Reach No. 4 begins at the upper end of the 2,000-ft floodway and extends through the transition from the 2,000-ft floodway to the 3,000-ft floodway, a distance of 11,200 ft. Reach No. 5 begins at a point 2,000 ft below Westmoreland Road, and approximately 2,000 ft above the old West Fork River crossing, to the junction of the East and West forks, a total length of 8,950 ft.

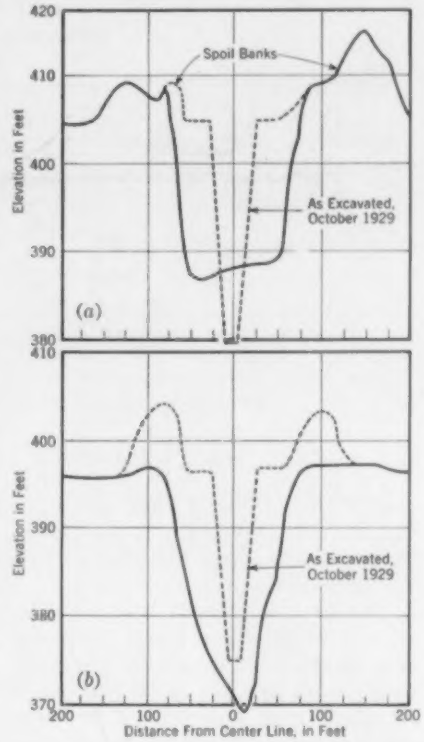
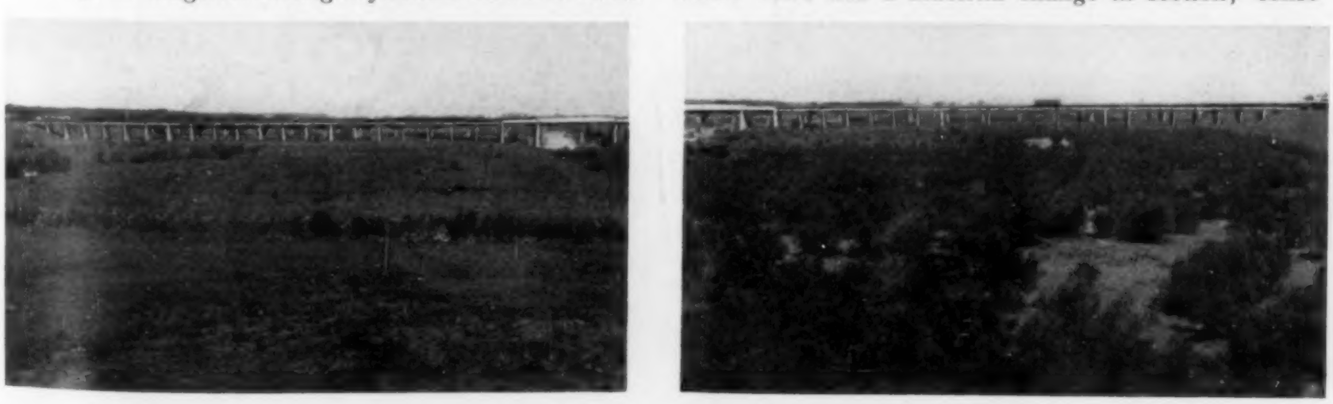


Fig. 3. Typical Pilot Channel Cross-Sections in (a) Reach 1 and (b) Reach 4

TECHNIQUE AND RESULTS OF COMPUTATIONS

The water-surface falls through Reaches 1 and 2 were determined by actually measured elevations at each end of each reach. The fall through Reach 3 was determined by an actual measured elevation at the lower end of the reach and an interpolated elevation at the upper end of the reach. The falls through Reaches 4 and 5 were determined by interpolated elevations at both ends of each reach. After determining the fall through the various reaches, the slope of the water surface was calculated. It was recognized that non-uniform flow occurred where there was a material change in section; conse-



Character of Surface Roughness in Floodway—Views Taken Looking North from Cadiz Street Viaduct
West Side (Left) Has a Few Scattered Willows 8 to 10 Ft High; East Side (Right) Has a Thicker Growth, to About Same Height

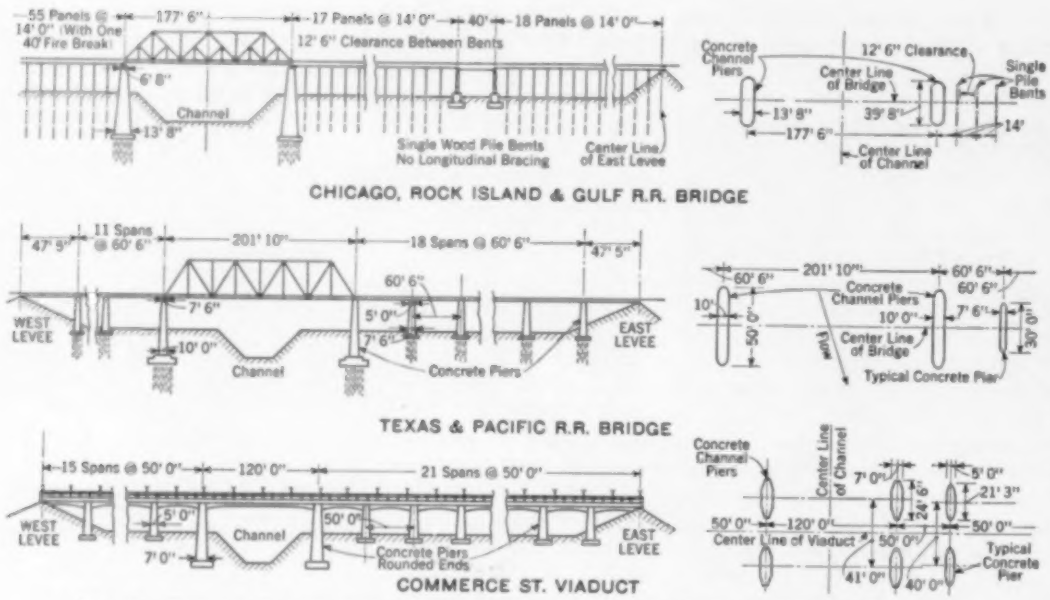


FIG. 4. PARTIAL PROFILES AND DETAILED PIER PLANS OF THREE FLOODWAY CROSSINGS

quently the slope of the energy gradient was determined for all five reaches (see Table I). Owing to the low velocities encountered, there was no material difference in the two slopes except in Reach 4.

The cross-sectional area of each reach was determined by the weighted average of several cross-sections within the reach. As previously stated, these cross-sectional areas were arrived at by the use of old floodway cross-sections and comparatively new channel cross-sections taken by U. S. Army Engineers. The hydraulic radius of each reach was obtained by taking the weighted average of all the hydraulic radii as computed for each cross-section. The discharge throughout the length of floodway was assumed as constant since there was no large amount of water entering the floodway through the levees.

The results of the calculations for n are shown in the last column of Table II. Values of n were found to vary from 0.046 in Reach 1 to 0.058 in Reach 3. An average value for the entire length of both the 2,000 and 3,000-ft floodways was found to be 0.054. This value was found by using the total fall through the floodway. As shown in the profile of the water surface (Fig. 1), there was found to be some drop through the various structures crossing the main floodway; but in no instance within the limits of the five reaches considered was the drop found to be greater than 0.2 ft from 100 ft above the structure to 100 ft below it. The total drop through the seven viaducts below the forks of the river was found to be 0.7 ft. By deducting this fall from the total fall through the floodway, the value of n was found to be 0.052 as compared with the above value of 0.054. For only the natural conditions of the floodway, the value of 0.052 is probably the more nearly correct of the two.

It will be remembered that these values of n are for the entire floodway, including the channel and borrow pits. It seems at first that they are rather high, but comparing them with values obtained on other floodways, and taking into consideration that this floodway had not been cleared within the six years previous to the flood, they appear to be correct. Values obtained on the straight floodway of the Little River Drainage District in southeast Missouri, by C. E. Ramser, hydraulic engineer, U. S. Bureau of Public Roads, reported in the April 5, 1928, issue of *Engineering News-Record*, ranged from 0.0445 to 0.052 in a cleared course of floodway, and from 0.0745 to 0.0775 in an uncleared course. However, it is difficult to make a comparison of two floodways because of the entirely different conditions encountered. With the Trinity River floodway cleared of all trees and brush as it originally was, the value of n should be reduced to somewhere between 0.045 and 0.050.

TABLE II. HYDRAULIC ELEMENTS AND VALUES OF n IN KUTTER'S FORMULA FOR THE FLOODWAY

(For Q = 77,000 Cu Ft per Sec)

Reach	Length in Stations	Fall in Ft	Energy Slope S	Weighted Average Area A	Weighted Average Hydraulic Radius, R	Average Depth of Water	C	Kutter's n
1	55.5	1.1	0.000198	26,718	13.46	12.9	55.83	0.046
2	43.0	0.9	0.000209	28,536	14.13	13.1	49.66	0.054
3	27.5	0.7	0.000254	27,980	13.87	12.7	46.37	0.058
4	112.0	3.9	0.000348	27,838	10.59	9.4	45.57	0.054
5	89.5	2.3	0.000257	30,914	10.40	9.4	48.18	0.052
Total length of floodway	393.0	10.9	0.000277	28,716	11.85	11.5	46.98	0.054

The writer wishes to acknowledge work which greatly assisted in the compilation of this report, by the following: the firm of Myers, Noyes and Forrest; the Water Resources Branch of the U. S. Geological Survey; the Corps of Engineers, U. S. Army; and the Texas State Reclamation Department. He is also indebted to Fred C. Scobey, M. Am. Soc. C.E., for valuable criticisms in the preparation of this paper.

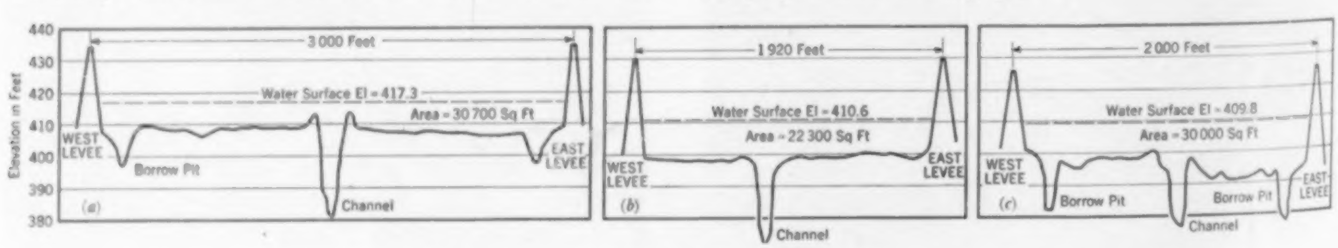


FIG. 5. TYPICAL FLOODWAY CROSS-SECTIONS (a) AT WESTMORELAND ROAD, (b) AT COMMERCE STREET, (c) 500 FT NORTH OF HOUSTON STREET

Silt Problems of Imperial Irrigation District as Affected by Completion of Boulder Dam

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Construction of the Boulder and Parker dams has considerably lowered the silt content of the Imperial Irrigation District's water supply. As a result, dredging at the diversion point has been discontinued, and the costly cleaning of canals and laterals has been reduced. Coincidentally, certain other problems have arisen having to do with increased seepage and increased growth of vegetation and moss. Ultimately, conditions in the irrigation district will be still further altered by completion of the All-American Canal and the desilting works at its head. Meanwhile, however, the trends are clearly discernible, and permit plans to be made for coping with the incidental problems that will accompany the major benefits. This paper, discussing the changes that have taken place thus far, was on the joint program of the Hydraulics Division and the Irrigation Division at the 1939 Annual Convention of the Society.

Imperial Irrigation District comprises 612,000 acres of land in Imperial County, in the extreme southeastern portion of California. The District also owns and operates a subsidiary company in Mexico, delivering water to over 200,000 acres of land in Baja, California. The District is now operating and maintaining approximately 3,000 miles of canals, varying in capacity from 10,000 to 1 cu ft per sec. The water supply for the entire area, for both domestic and irrigation purposes, is obtained from the Colorado River, the present diversion point being at Hanlon Heading, a short distance north of the international boundary.

One of the major operating problems throughout the District has been the removal of the vast quantities of silt continuously brought into the canals and laterals with the water from the Colorado River. With the completion of Boulder Dam, changes in the quantity and character of the incoming silt began to be apparent. On the whole, these changes have been beneficial, though the reduction in silt content does involve certain new problems that require attention. It is the purpose of this paper to compare past and present conditions, and to show the changes that have taken place so far.

In this discussion it must be borne in mind that the "transition period" is not yet over, and that therefore present conditions in many ways may not reflect those that will exist later. For example, with the completion of the All-American Canal, the diversion point will be moved upstream about 25 miles to Imperial Dam. Not only will diversion conditions be much improved and better control secured, but also the desilting works at the new headworks will eliminate the heavy silt which at present is causing considerable trouble. Another factor yet to be dealt with is the release of large flows from Boulder Dam. Storage commenced at the dam in February 1935, and since that time the release of water has been limited, except for a few days in the spring of 1939, to irrigation requirements on the lower river. As a result, the flow in the river past Hanlon Heading has been small—usually from 500 to 1,500 cu ft per sec—and at times there has been none at all. Now that the reservoir has filled, it is anticipated that within a short time the full regulated flow of from 20,000 to 25,000 cu ft per sec will be released continuously. What this larger quantity will do in transporting heavier materials from the river bed is not known, but it is believed there will be some increase in the size and weight, as well as percentage, of the bed silt reaching Hanlon Heading. This will add to the problems with which the District is now contending, at least until the All-American Canal is placed in service.

Diversion Structures at Cudahy Check on Alamo Canal, Showing Typical Encroachment on Freeboard Caused by Silt Deposits Which Raise the Canal Grade

A 3 1/2-Ft Lowering of Canal Grade Resulted from the Operation of a Desilting Basin Upstream from This Point

But to get back to present and past conditions. In the past, during each flood season the river bed was scoured out to a considerable depth. With the receding flow, it gradually filled in again, but in order to divert water to the main canal during this period, it was necessary to put in a temporary weir across the river. The District developed a special type of brush mat for this purpose, as it was necessary to remove the weir prior to the next flood season in order to protect the Yuma Valley on the opposite side of the river.

Now that the river flow has been regulated, the bed of the river maintains a sufficient elevation so that the

diversion can be made without the use of a weir, although considerable quantities of sand from the bed are sluiced into the canal when it is necessary to divert the entire flow.

Although Boulder Dam has very greatly reduced the total silt content, the clear water discharged from it loads itself with material from the bed of the river below the dam—and also below Parker Dam, since its construction—with the result that there has been little change, if any, in the percentage of bed load. (Of course, by reason of the reduced flow, the actual quantity of bed load is much less.) On the other hand, the total silt content has been much reduced. Where formerly it was not uncommon for the water to have a total silt content averaging 10 per cent by volume for periods of a month or more, with a maximum for several days at a time of 30 per cent, the total silt content now is usually under 0.1 per cent by volume. It consists almost entirely of fine sand.

REMOVAL OF SILT DECREASES FREQUENCY OF CANAL CLEANINGS, BUT THIS IN TURN RESULTS IN INCREASED GROWTH OF VEGETATION

In the past, during flood seasons, the volume of heavy silt (sand) entering the main canal was greater than the canal could transport. As a consequence the bottom of the head end would build up, increasing the difficulties of diversion as the flood receded. In order to maintain the elevation required for diversion, the District operated two large suction dredges—one a 20-in. and the other an 18-in.—in the canal immediately below the diversion gate. These dredges were operated for four or five months each year, depending upon river flow conditions, discharging the sand back into the river. During drought periods it was possible, in this manner, to build a sand dam across the river and divert the entire flow into the canal. Now, however, the diversion canal grade has been stabilized—that is, the grade is such that the water is able to transport the silt load—and suction dredging has been discontinued.

SPRAYING VEGETATION ALONG CANAL TO CONTROL GROWTH
Chemical Treatment and Burning Are the Most Effective Methods of Bank Clearing

CHANGED CONDITIONS ON THE MAIN CANALS SINCE COMPLETION OF BOULDER DAM

The principal difference noted in conditions on the main canals since the completion of Boulder Dam has been the greater difficulty in transporting the heavy silt (sand), now that the large volume of suspended silt has been removed. In many sections the tendency to form sand bars is much greater. There has been a steepening of grade at a number of points, requiring extensive raising of canal banks to maintain freeboard. On one canal—the East Highline—the bottom at the head is 2 ft higher this year than last, and is continuing to rise for 10 or 12 miles downstream. This has made it necessary to raise the water surface in the Alamo Canal from which it is diverted, changing conditions for many miles upstream.

The same condition has also been noted at points where the main canals are sluiced. The absence of the suspended silt results in the sand forming a more compact bottom, which the increased velocity of the water during sluicing has more difficulty in dislodging.

As in all other parts of the canal system, the reduction in silt content has resulted in a marked decrease in the rate of formation of berms along the main canal banks. In the past, these would build out into the canal at some points as much as 6 or 8 ft, and the root growth in the berms would resist the flow even where velocities were high. Now the formation of such berms is very slow, and their removal no longer presents a problem. In fact, at a few points this lack of berm formation has resulted in some bank erosion and sloughing.

Another change in conditions noted on all sizes of canals has been an increase in seepage in many places, due to the absence of the large volume of fine suspended silt which had helped to seal the banks. This change has not been as noticeable on the main canals, however, as on the smaller canals and laterals.

SMALL CANALS AND LATERALS

Decrease in silt content of the water has greatly reduced the silt removal problem on the small canals and laterals; they do not silt up as rapidly and the rate of berm growth has been greatly reduced. In the past, the District cleaned, on the average, 3,500 miles of canals a year, removing an estimated 3,500,000 to 4,000,000 cu yd of silt, a large part of which was from the lateral system. As a result, canal banks were rapidly increasing in height and width, with an ever-increasing cost as grading machinery became necessary to move the spoil to the outer

IN COMPLETELY DESILTED WATER, MOSS GROWTH IS RAPID AND OFTEN CAUSES TROUBLE

edge of the bank and structures had to be raised. Already the amount of cleaning required has been greatly reduced and will be further reduced after the All-American Canal is in operation and the canal system has adjusted itself to the clearer water.

With the reduction in cleaning operations, however, there has been a noticeable increase in growth of vegetation on the banks. In the past, a large part of the bank clearing was done by hand, but as the root systems developed this method ceased to be practical. A number of other means have been tried out, such as disking with heavy multiple disks pulled by tractors, cutting with a special type of mower directly connected to a small tractor, spraying with chemicals, and burning. Of these, the last two are by far the most effective. Each has its place, and from results obtained so far it is believed that the growth not only can be controlled but also that over a period of years it will be nearly all eliminated.

As has already been mentioned, the elimination of the suspended silt has caused some increase in canal seepage. In the past, there has been a gradual increase in the height of water in the lateral system, as the canal banks were raised by cleaning operations, and the depositing of silt at the head ends of farm lands required a higher water level in District canals to make delivery. As a result, most of the lateral system is now several feet above the adjoining land level. This has increased the tendency for the canals to seep, especially since the banks contain considerable foreign matter, such as roots and vegetation, removed with the silt. As long as the silt content of the water was high, it did not take long for the inside of the

Sloughing of the Banks of This Drain Has Been Caused by Seepage

banks to seal off after a cleaning, but now this takes place very slowly, and there is more seepage in the meantime. However, after the All-American Canal is in operation and all the heavy silt is being removed, it will be possible to operate the canal system on much flatter grades than heretofore. This will lower the elevation of water in the canals, thereby reducing the pressure, and it is believed that this will more than offset the present increase in seepage.

This has proved to be the case on several canals where clear water has been obtained by passing the flow through a desilting basin. Downstream from the basin the water surface in the canal has lowered several feet and a marked decrease in bank seepage has been observed. This does not mean that canal seepage will not always be serious, but it does indicate that, in general, conditions will not be much more troublesome than they have been in the past.

During the past year, the growth of moss has been observed in one or two canals where the water is nearly clear. Just how much of a problem moss will be in the future cannot be stated at this time, but without doubt it is going to cause trouble. However, as it is anticipated that during most of the year there will be enough fine silt in the water to make it cloudy, it is not believed that moss growth will ever become as serious as in some projects where very clear water is used.

Cleaning a Drainage Channel

Under the changed conditions there has been some increase in erosion in laterals immediately below checks and drops, but so far it has been of a minor nature, and has not given the District any great concern.

Drainage Canals and Outlet Channels

The District operates and maintains over one thousand miles of drainage canals. In the past, varying amounts of fine silt reached the drains through surface inlets from the farms, requiring more frequent dredging than would otherwise have been necessary. Now practically no silt reaches the drains, which has made it possible to materially increase the length of time between cleanings. However, there has been an increase in the growth of moss in the drains, and without doubt this will develop into a serious problem within the next few years.

An increase in the sloughing of drain banks has been observed at a number of points. In general this is occurring where the drain is located parallel with, and not far from an irrigation canal, or where the adjoining farm land is irrigated to within a few feet of the drain. The cause is believed to be the large decrease in the amount of suspended silt in the water flowing in the canal or used in irrigating the land, which has resulted in more rapid penetration of the water and an increased amount of seepage reaching the drain. However, the increase in penetration is proving of considerable benefit in the production of crops, particularly on land of the harder type—that is, where the soil is composed of the finer type of silt—and increased yields have been had in many cases.

Most of the drainage and waste waters of Imperial Valley reach Salton Sea through either the New River or the Alamo River. These two channels also serve as outlets for most of the sluiceways used by the District to sluice the silt out of canals. Where these two channels enter Salton Sea, the formation of deltas has been quite rapid in the past, and has created a problem very similar to that on the Colorado River delta. For each of the rivers, the District has maintained two outlet channels which are used alternately, flow being passed through one while the other is being cleaned out or shifted to a new location. The reduction in the amount of silt entering Imperial Valley has materially decreased the rate of delta expansion, thereby making it possible to use an outlet channel for a much longer period. However, the maximum benefit in this regard will not occur until after the canal system has readjusted itself, following the elimination of the heavy silt by the All-American Canal.

In conclusion it may be said that, in general, the effect of Boulder Dam has been to materially reduce the silt problems of the Imperial Irrigation District, although a complete solution will not be possible until the All-American Canal is in operation.

Surveying in Ancient Times

Contributions of Egypt, Babylon, Greece, and Rome

First of Two Articles on the History of Surveying

By W. H. Rayner

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In this article and the one to follow it in November, Professor Rayner sketches briefly and interestingly the development of surveying from the days of the Egyptian "rope stretchers" to the invention of the transit. The present installment is confined to the methods and tools of ancient times—like the "dioptra" of the Greeks and the "groma" and "chorobates" of the Romans. These articles were originally presented as a paper before Committee VIII (Surveying and Geodesy) of the Civil Engineering Division, Society for the Promotion of Engineering Education, at the 47th Annual Meeting of that society, June 1939.

The history of a science or an art is an eminence from which we view the achievements of men who have striven for mastery in that particular field. A realization of the conditions under which the early surveyors worked, and of what they accomplished, should endow the student, the teacher, and the engineer with a becoming respect for the methods and instruments which serve his daily needs with such convenience, but which represent centuries of thought and effort. It is hoped that, in a small degree, the present paper and the one to follow it will serve this purpose.

The early history of surveying merges with that of mathematics—and, in fact, the theory of mathematics seems to have grown out of the practical use of numbers and calculations required in the commercial transactions of the ancients, such as the establishment of boundaries and the measurement of land areas. This relation between mathematics and surveying is indicated by the term applied to one of the earliest branches of mathematics, "geometry," which is derived from Greek words meaning "earth measurements."

Some authorities do not adhere to the rather general belief that the practice of land surveying began in the Nile Valley, and Lyman[1] thinks that Homer[2] is the author of the earliest allusion in any language to land surveying.

However, although Herodotus[3] is reputed to have recorded traditions not entirely warranted by the facts, we have this interesting statement from him regarding the origin of geometry. "They said also that this king [Sesostris] divided the land among all Egyptians so as to give each one a quadrangle of equal size and to draw from each his revenues, by imposing a tax to be levied yearly. But every one from whose part the river tore away anything, had to go to him and notify what had happened; he then sent overseers to measure out by how much the land had become smaller in order that the owner might pay on what was left, in proportion to the entire tax imposed. In this way, it appears to me, geometry originated, which passed thence to Hellas."

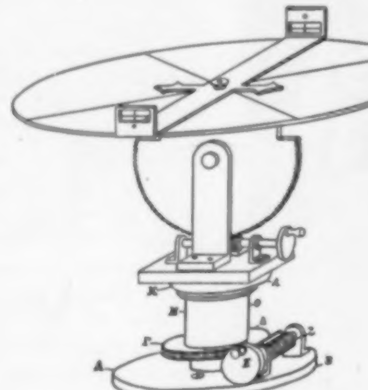

Fig. I. Draftsman's Idea of the Dioptra—an Instrument of 100 B.C. Which Included Many of the Essentials of the Modern Plain Theodolite

The Egyptians. While it is probably inaccurate to say that the practice of surveying began in Egypt, there is good evidence that the Egyptians were well in advance of other nations in this field, down to the Christian era. For example, as early as 1700 B.C. they computed the area of a circle by subtracting from the diameter one-ninth of its length and squaring the remainder, from which the value of π is found to be 3.1605—a value more accurate than the simple number 3 employed by the Babylonians and the Hebrews (I Kings 7:23).

The fact that the pyramids are quite accurately oriented with respect to the true meridian is good evidence that the directions of the north-south lines were determined by astronomical observations; and the fact that the Egyptian geometers or surveyors were called *harpedonaptae*, or "rope stretchers," is evidence that the accurate right angles of the pyramids and other structures were established by use of the 3:4:5 ratio.

The Babylonians. The Babylonians seem to have contributed more to the science of astronomy, used in their auguries, than to that of mathematics or surveying. However, they very early knew that the radius of a circle could be applied to the circumference as a chord exactly six times, and that each chord subtended exactly 60 degrees. They divided the day into 24 hours, the hour into 60 minutes, and the minute into 60 seconds. They also divided the circle into 360 degrees, each degree being a measure of one day's progress of the sun along its path amongst the stars, although they also knew at an early date that the yearly cycle consisted of slightly more than 360 days. However, their principal contribution to astronomy and to surveying practice was the division of the circle into 360 degrees.

The Greeks. Cajori[4] calls attention to the fact that when the knowledge of Egyptian geometry and mensuration came into the hands of the Greek philosophers it furnished the basis for speculation and development, in accordance with Plato's remark that "Whatever we Greeks receive we improve and perfect." Thus the 3:4:5 principle used by the

Egyptian rope stretchers was developed by Pythagoras into the famous theorem which bears his name. And to mention but the names of Euclid and Archimedes is sufficient to indicate the character of the advancement made by the Greeks.

But these philosophers felt it to be an ignoble use of their learning to apply it to practical affairs, and so it is that the Greeks made splendid contributions to the theory of mathematics but none to the art of surveying.

A notable exception to this general rule is Heron the Elder,[5] a Greek living in Alexandria about the period 150–100 B.C. He wrote a treatise entitled *The Dioptra,* three copies of which are extant. This book contains many very interesting propositions, notably the method of determining the area of a triangle from the lengths of the three sides; but our interest lies in its description of the construction and use of the important surveying instrument, the dioptra.

Briefly described, the dioptra (Fig. 1) consisted of a peep-sight carried on a bronze alidade, pivoted at its midpoint and moving about a circular disk which had engraven upon its limb 360 single degree divisions. By an ingenious use of gears and clamps the alidade and disk could be rotated with considerable precision about both a horizontal and a vertical axis. The whole device was mounted on a supporting column with pedestal. The alidade could be clamped to, or released from the underlying disk by means of a thumbscrew at its center. Thus, it is evident that this instrument included many of the essential principles of the modern plain theodolite except the telescope.

Angular measurements, however, were used exclusively in astronomical observations; degrees seem never to have been used in land measurements until Digges in 1571 constructed his theodolite, to be described later.

For leveling operations, the circular disk and alidade of the dioptra were replaced by a sighting device consisting of a bronze tube, about 8 ft long, laid in a groove cut into a wooden bar. Each end of the tube had a right-angle elbow from which a glass-tube riser extended upward a few inches. By this means a water column would show in each glass tube, thus establishing a level line of sight.

ROMAN SURVEYORS AND THEIR INSTRUMENTS

The Romans. In contrast to the Greeks, the Romans were more interested in the practical application of their knowledge of mathematics, which they had received from others, to engineering projects and military operations, than in any endeavor to increase it. This fact is substantiated by the statement of Frontinus,[6] a Roman engineer writing in the second century A.D. that, "our method of surveying was first instituted by the science of the Etruscan soothsayers." Further, it is interesting to note that all important surveys were begun only after taking the auspices!

The *gromatici* or *agrimensores,* as the Roman surveyors were called, came to constitute a recognized profession. Their services were required to lay out temples and military camps, to make surveys for the construction of roads and aqueducts, and to establish property lines for the holdings of citizens and soldiers. The number of the *gromatici,* beginning with L. Decidius Saxa, the first to be mentioned[7] (who was employed by Antony in the measurement of camps), increased steadily, and later schools were established for training the members of the profession.

As the legal aspects of land ownership became more complicated, the schools for the *agrimensores* established a separate course of study for those who wished to specialize in this class of surveys. It is recorded that in the later years of the empire the members of this profession received large salaries and were honored with titles.

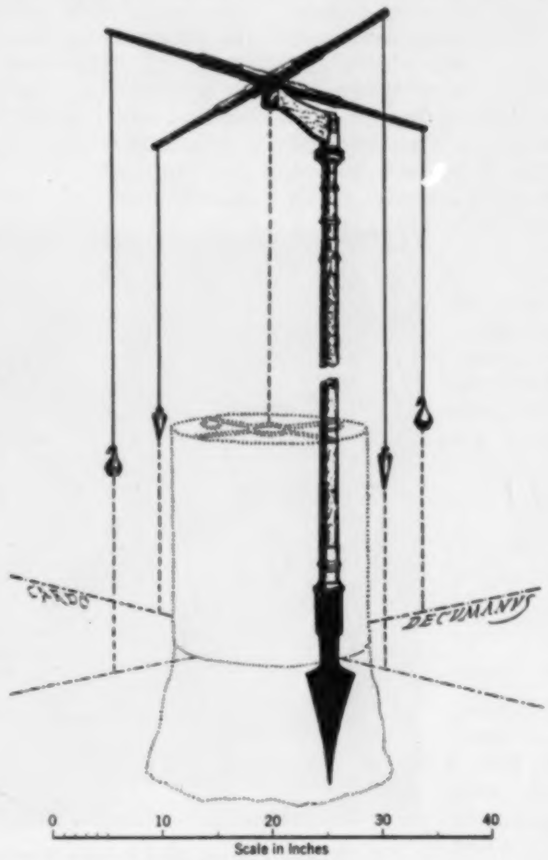

Fig. 2. The Groma, Surveying Instrument Used by the Romans to Establish Two Lines at Right Angles to Each Other

Roman Instruments. Three instruments were in use by the Romans, namely, the dioptra (already described), the groma, and the chorobates.

From the writings of the *gromatici* and from engravings on their tombstones it is possible to construct a fairly faithful likeness of the groma, the instrument they used; and in 1912 an actual specimen was found in Pompeii. A photograph of this decayed instrument and a reconstruction of it are given in a scholarly discussion by M. Della Corte,[8] dealing with the instrument and the practice of the profession in early times. Figure 2 shows his reconstructed groma. It consisted merely of cross-arms fixed at right angles and pivoted eccentrically upon a Jacob's staff. From the ends of the arms plumb lines were suspended.

The whole purpose and use of this instrument was to establish upon the ground two lines at right angles to each other, called the *cardo* (north-south) and the *decumanus* (east-west). Since the cross-arms were pivoted, they could be rotated in azimuth, which made it possible to orient the cardinal lines in any direction.

Vitruvius in his *Ten Books on Architecture*[9] furnishes the following description of the chorobates, from which has been drawn the illustration in Fig. 3. The superiority which Vitruvius ascribes to this instrument is probably due to the more accurate control of the line of sight effected by means of a straightedge approximately 20 ft long.

"I shall now treat of the ways in which water should be conducted to dwellings and cities. First comes the method of taking the level. Leveling is done either with dioptrae, or with water levels, or with the chorobates, but it is done with greater accuracy by means of the chorobates, because dioptrae and levels are deceptive. The chorobates is a straightedge about 20 ft long. At

the extremities it has legs, made exactly alike and jointed on perpendicularly to the extremities of the straightedge, and also cross-pieces, fastened to tenons, connecting the straightedge and the legs. These cross-pieces have vertical lines drawn upon them, and there are plumb lines hanging from the straightedge over each of the lines. When the straightedge is in position, and the plumb lines strike both the lines alike and at the same time, they show that the instrument stands level.

"But if the wind interposes, and constant motion prevents any definite indication by the lines, then have a groove on the upper side, 5 ft long, one digit wide, and a digit and a half deep, and pour water into it. If the water comes up uniformly to the rims of the groove, it will be known that the instrument stands level. When the level is thus found by means of the chorobates, the amount of fall will also be known."

Accuracy of Ancient Surveys. The accuracy attained in the ancient surveys is a matter of interest, and we have the following data on the pyramids:[7]

Place	King	Date B.C.	Base Ft	Error Ft	Az.
Medum	Sneferu	4750	473.50	0.52	24′25″ W
Gizeh	Khufu	4700	755.73	0.05	3′43″ W
Gizeh	Khafra	4600	706.24	0.12	5′26″ W
Gizeh	Men-kaura	4550	346.13	0.25	14′ 3″ E
Dahshur	?	?	621.58	0.31	9′12″ W
Dahshur Small	?	?	172.05	0.10	10′12″ W

The errors given for the lengths of the sides are mean values for the four sides. The angles at the base of Khufu have a mean difference from 90 deg of 12 sec, while the errors in angles for the other pyramids for which data are given, vary up to 4 min.

Professor Merriam[10] reports the investigation of a Greek tunnel at Samos by Ernest Fabricsus in 1884. This tunnel, constructed some time before 526 B.C., is about 3,000 ft long, having a cross-section about 5 ft square. It was dug straight from both ends and joined at the middle, with errors in alinement of about 20 ft and in elevation of about 8 ft.

This author also speaks of a tunnel at Jerusalem between the Virgin's Pool and Siloam which is thought to date back as far as the time of Solomon. It is about 1,600 ft long, and in alinement has the shape of the letter S. It was driven from both ends but several false headings show the various attempts necessary to effect a juncture. The error in elevation at meeting was only 1.1 ft, which may have been a matter of luck considering the crude work in alinement. An interesting inscription in the tunnel records the joy of the workmen when the two headings met.

Henry Briggs[11] cites the very human document of Frontinus, *Gromatici Veteres*, which quotes from the report (A.D. 152) of Nonius Datus, the engineer in charge of construction of the tunnel at Saldae, Algeria. "Every one," said Nonius, "had given up hopes that the two opposite sections of the tunnel would meet. . . . As always happens in these cases, the fault was attributed to me, the engineer, as though I had not taken all precautions. . . . What could I have done better? For I began by surveying and taking the levels of the mountain; I marked most carefully the axis of the tunnel across the ridge; I drew plans and sections of the whole work. . . . The contractor and his assistants had made blunder after blunder. In each section of the tunnel they had diverged from the straight line towards the right, and had I waited a little longer before returning [from a business journey], Saldae would have had two tunnels instead of one."

INTAKE PORTAL OF A ROMAN TUNNEL OF THE FOURTH CENTURY B.C.

Some Three-Quarters of a Mile in Length, This Tunnel Was Constructed to Lower the Level of the Alban Lake

The successful construction of the Roman aqueducts in evidence, however, that these works must have been designed on the basis of rather accurate surveys, both as to alinement, distance, and elevation.

It is interesting to note in this connection that as late as Napoleon's time, his engineers[7] found a difference in elevation of 29 ft between the Mediterranean and the Red Sea, which erroneous report caused the abandonment of a project for a Suez canal.

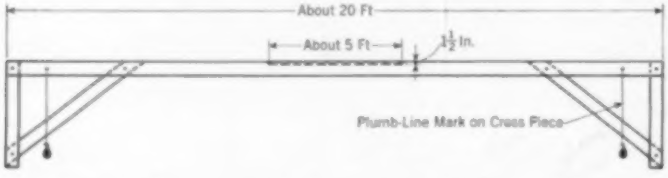

FIG. 3. THE CHOROBATES, A LEVELING INSTRUMENT DESCRIBED BY VITRUVIUS

When Wind Interfered with the Plumb Bobs, Water Was Poured Into the Groove in the Center of the Long Straightedge to Provide an Auxiliary Leveling Method

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Vicissitudes of an Engineering Formula

Du Buat's Expression for Bend Loss Has Appeared in Many Forms

FROM THE HYDRAULICS DIVISION PROGRAM AT THE 1939 SPRING MEETING

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WE sometimes dwell upon the fact that engineers have an exciting life and may expect all sorts of adventures. Apparently engineering formulas may likewise have many vicissitudes—as witness the so-called Du Buat formula for loss of head in bends.

Pierre Louis George Du Buat was born in 1734 in Normandy and died in 1809 in northern France. His whole life was spent in the French military service except for a short time during the French Revolution, when he fled from the country. His first hydraulic studies began in 1776 when he was 42 years old. He first wrote out a theoretical treatise, and then, having attained a responsible position in the French military organization, he secured authority and funds which enabled him to carry out a large number of experimental investigations.

In 1786 Chevalier Du Buat published a two-volume work entitled *Principes d'Hydraulique* which is sometimes stated to be the first systematic treatise ever written covering the field of hydraulics. It is said to have been translated into English and German, but I have never seen any translation. It was republished in Paris in 1816 with the addition of a third volume dealing with the subject of heat.

One of the subjects Du Buat studied was the additional head required to maintain flow in pipes having curves or bends as compared with the head required to maintain the same flow through straight channels. From his experiments he devised a formula for the additional head around a bend as follows:

$h = \dfrac{v^2 \sin^2 a}{3{,}000}$, in which a cannot exceed 36 deg. All the linear quantities are in inches. As this formula was devised before the French Revolution, and hence before the introduction of the metric system, the "inch" used was the old French inch which was nearly the same as our English inch.

In his experiments Du Buat used iron pipes with curves made of lead pipe all of which were either 1 in. or 2 in. in diameter. He states that many of his experiments agreed in their results closely, but some of them, for various reasons, were not entirely consistent and he therefore rejected such results. The experiment which he chose as best for determining the constant in his formula was carried out on a pipe 1 in. in diameter and 10 ft long. The flowing water had a velocity of about 6 ft per second.

The angle a in his formula is based upon a rather complex definition, and the whole formula is based upon a theory of flow around bends which now seems rather fantastic. He considered that the water flowing around a curve struck against the outer bank and then bounced away, making the angle of rebound equal to the angle of incidence. In a long curve there could be several of these rebounding angles. If the radius of curvature were not constant, the different angles would not need to be the same size. In the case of a long curve, the quantity $\sin^2 a$ would be changed to $\Sigma \sin^2 a$ or the sum of the terms taken separately. It is the subsequent history of this formula which I wish to tell briefly.

In 1850 the U. S. Army Engineers began a comprehensive study of the Lower Mississippi River. After ten years of work Capt. A. A. Humphreys and Lieut. H. L. Abbot published a quarto report of about 700 pages entitled *Physics and Hydraulics of the Mississippi River*. The volume was first published in 1861 and was reprinted in 1876. Chapter III of this work contains a rather comprehensive review of all hydraulic literature published up to that time relating to the hydraulics of rivers and highly commends Du Buat's work. The report contains an elaborate account of the measurements of the velocity and discharge of the Lower Mississippi River and formulas for computing these quantities. In the course of the discussion, the authors needed to determine the effect of bends in the river and adopted Du Buat's formula for this purpose. Changed to English measures using feet, they gave the formula as follows:

$$h = \frac{v^2 \sin^2 a}{266.3}$$

They then stated that it could not be expected that a formula based on measurements in a small pipe would give proper results on a large river like the Mississippi; but that if the formula were changed so as to read

$$h = \frac{v^2 \sin^2 a}{134}$$

PRINCIPES

D'HYDRAULIQUE,

VÉRIFIÉS

Par un grand nombre d'Expériences faites par ordre du Gouvernement.

OUVRAGE dans lequel on traite du mouvement uniforme & varié de l'eau dans les Rivières, les Canaux, & les Tayaux de conduite; de l'origine des Fleuves, & de l'établiſſement de leur lit; de l'effet des Ecluſes, des Ponts & des Reverſoirs; des Jets-d'eau; de la Navigation tant ſur les Rivières que dans des Canaux étroits; de la réſiſtance des Fluides en général; & de celle de l'Air & de l'Eau en particulier.

Par M. le Chevalier DU BUAT, ancien Chevalier de l'Ordre de Saint Jean de Jéruſalem, Chevalier de l'Ordre Royal & Militaire de Saint Louis, Lieutenant-Colonel au Corps Royal du Génie.

Ut tandem Philoſophia & Scientiæ ſolidis experientiæ nitantur fundamentis. (BACON.)

NOUVELLE ÉDITION, revue, & conſidérablement augmentée.

TOME PREMIER.

A PARIS,

DE L'IMPRIMERIE DE MONSIEUR.

M. DCC. LXXXVI.

TITLE PAGE OF DU BUAT'S *Principes d'Hydraulique*, 1786, PROBABLY THE FIRST SYSTEMATIC TREATISE ON HYDRAULICS

it would fit their experimental measurements very satisfactorily. They gave a small table to show the results of testing this formula by measurements at several places, but did not give their data in sufficient detail to show conclusively just how the formula was applied. The published table apparently has some typographical errors but the data do not enable one to tell which figures are in error. It seems to me uncertain as to whether they determine the angle a by the same method that Du Buat used. Apparently they thought their most precise test of the formula was by measurements made near Vicksburg, Miss., on a stretch of the Mississippi eight miles long having near the middle a sharp 180-deg bend.

In his *Mechanics of Engineering*, published in 1890, page 770, Prof. Irving P. Church says, "According to Humphreys' and Abbot's researches on the Mississippi River, the loss of head due to a bend may be put—

$$h_r = \frac{v^2}{536}\,\frac{6\Delta}{\pi}\text{,''}$$

in which Δ is the total angle of curvature stated in circular measure. This formula differs much in appearance from the one published by Humphreys and Abbot. Some time before his death, I wrote to Professor Church calling his attention to the difference in form and asked if he had any notes regarding the reason for his modifying the appearance of the formula. He answered that he had no such notes and no recollection about the matter. It is rather easy to devise a plausible explanation of Prof. Church's change in the formula.

The late Harrison P. Eddy published in the *Engineering News-Record* for September 29, 1921, page 516, a brief article entitled "Effect of Curvature Upon Flow in Open Channels." He quotes Church's statement regarding Humphreys and Abbot and says that they were probably the earliest engineers to attempt a determination of the loss of head caused by bends in open channels. He then quotes the formula as follows:

$$h_e = v^2/536 - 6A/\pi\,.$$

A little later I called his attention to the radical change embodied in this formula as compared with the way it was printed by Church. Some time afterward he told me that he had looked into the matter when he returned to his office and found that the assistant who had made the researches, the results of which were given in his article, had written the formula with a dot between the two fractions to indicate multiplication. When the manuscript was typed, the stenographer did not understand the significance of the dot but mistook it for a minus sign, and the error was not discovered by anyone before publication.

These are the various forms in which Du Buat's formula has appeared in the course of 135 years. The subject is a rather minor one in the whole field of hydraulics although it has attained considerable importance under some circumstances. Apparently Du Buat's formula did not have any well-founded basis when it was first proposed, embodying errors and misconceptions; and it has been published in different forms which probably have no validity at all. One may wonder whether it will still continue to appear in various mutilated forms in the coming centuries.

ENGINEERS' NOTEBOOK

This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems. Reprints of the complete department, $8^1/_2$ by 11 in., suitable for binding in loose-leaf style, are available each month at 15 cents a copy.

Square Sections of Reinforced Concrete Eccentrically Loaded in Two Directions

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IN this article is presented a method of analyzing the stresses in square columns of reinforced concrete when subjected to the action of a concentric load, P, and two unequal bending moments, M_1 and M_2, acting at right angles to each other, as indicated in Fig. 1. Practically every column in a reinforced concrete building is subjected to such action; yet in spite of its importance there are in the current technical literature no references to this problem. (Special symmetrical cases have recently been published by the writer—"Diagonal Bending of Square Concrete Sections," CIVIL ENGINEERING for August 1938, and "Square Concrete Sections Subjected to Thrust and Diagonal Bending," CIVIL ENGINEERING for January 1939.)

The following symbols are used:

D = length of diagonal
d = distance from corner to reinforcing bar
M = bending moment
n = ratio of moduli of elasticity
e = eccentricity
f_c = maximum compressive stress in concrete
f_s = maximum tensile stress in reinforcing bar
k = distance from apex of compression area to neutral axis, divided by D
P = magnitude of load
p = steel ratio
θ = angle between diagonal and line connecting center of section and point of application of load

The stresses produced in the column of Fig. 1 will be identical to those caused by a single concentrated load of magnitude, P, acting at a distance

$$e = \frac{\sqrt{M_1^2 + M_2^2}}{P} \qquad [1]$$

from the centroid of the square. The angle between the plane containing the equivalent single load and the axis of the column, and the plane of the diagonal, is determined from

$$\tan (45° - \theta) = \frac{M_1}{M_2} \dots\dots\dots\dots\dots\dots [2]$$

In order to express the stresses acting upon a cross-section of the member in terms of P, e, and θ, certain assumptions must be made. Thus tensile stresses in the concrete are disregarded, and the neutral axis is assumed to be perpendicular to the plane of bending.

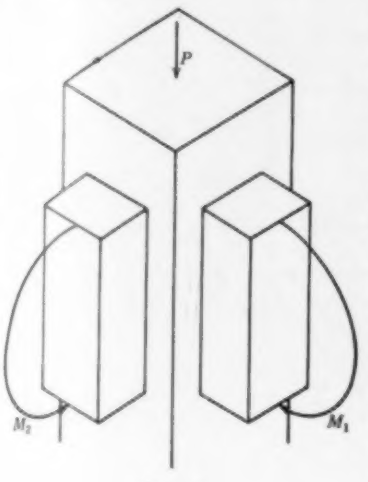


FIG. 1

In Fig. 2 is shown a square concrete section reinforced with four corner rods and subjected to the action of a single concentrated load, P. Depending on the eccentricity, e, and the angle of eccentricity, θ, the compressive stresses will form a tetrahedral volume as shown in Fig. 2(a); a volume which is most conveniently treated as a difference between a large tetrahedron and a small tetrahedron as indicated in Fig. 2(b), or a tetrahedron reduced by the volumes of two smaller ones as shown in Fig. 2(c).

Consider a square section $ABCD$, having compressive stresses over a triangular portion AMN and tensile stresses in three reinforcing bars (Fig. 3a). The position of the neutral axis found by eliminating P between the two equations which express respectively the equalities between the sum of the internal stresses and P, and the sum of the internal moments and Pe, thus:

$$P = \frac{f_c}{3} \times \frac{k^3D^2}{\cos 2\theta} + \frac{f_c npD^2}{4k}\left(2k - \cos\theta\right) \dots\dots\dots [3]$$

and

$$Pe = \frac{f_c k^3 D^3}{3 \cos 2\theta}\left(\frac{D}{2}\cos\theta - \frac{kD}{2}\right) + \frac{f_c npD^3}{4k}\left(\frac{1}{2} - \frac{d}{D}\right)^2 \dots\dots [4]$$

Eliminating the load, P, between Eqs. 3 and 4 gives for Case A

$$k^4 + k^3\left(2\frac{e}{D} - \cos\theta\right) + 3np\frac{e}{D}k\cos 2\theta - \frac{3}{2}np\cos 2\theta\left[\frac{e}{D}\cos\theta + \left(\frac{1}{2} - \frac{d}{D}\right)^2\right] = 0 \dots\dots\dots\dots\dots [5]$$

If

$$\frac{\cos\theta - \sin\theta}{2} < k < \frac{\cos\theta + \sin\theta}{2} \dots\dots\dots\dots [6]$$

then the compressive stresses will be distributed over a trapezoid $ABRM$ as shown in Fig. 3(b), where G indicates the projection of the centroid of the tetrahedron having AMN for a base, and G_1 is the projection of the centroid of the smaller tetrahedron having BRN for a base. For Case B, the position of the neutral axis is found from:

$$k^3 + \left(3\frac{e}{D} - \frac{3}{2}\cos\theta\right)k^2 - \frac{\cos\theta - \sin\theta}{4}\left(6\frac{e}{D} - 2\cos\theta - \sin\theta\right)k + 3np\frac{e}{D}\left(\cos\theta + \sin\theta\right)k - \frac{3}{2}\left(\cos\theta + \sin\theta\right)np\left[\frac{e}{D}\cos\theta + \left(\frac{1}{2} - \frac{d}{D}\right)^2\right] + \frac{(\cos\theta - \sin\theta)^3}{16}\left(4\frac{e}{D} - \cos\theta - \sin\theta\right) = 0 \dots\dots [7]$$

For Case C (see Fig. 3c), the value of k is given by

$$k^4 + \left(2\frac{e}{D} - 3\cos\theta\right)k^3 + 3\cos\theta\left(\cos\theta - 2\frac{e}{D}\right)k^2 - \left[\cos^2\theta + 3\frac{e}{D}\left(np\cos 2\theta - 1\right)\right]k - \frac{e}{2D}\cos\theta\left(1 + 2\sin^2\theta\right) + \frac{\cos 2\theta}{8} + \frac{3}{2}np\cos 2\theta\left[\frac{e}{D}\cos\theta + \left(\frac{1}{2} - \frac{d}{D}\right)^2\right] = 0 \dots\dots\dots\dots [8]$$

The greatest unit compressive stress can be found for Case A by solving Eq. 3 with respect to f_c. For the other

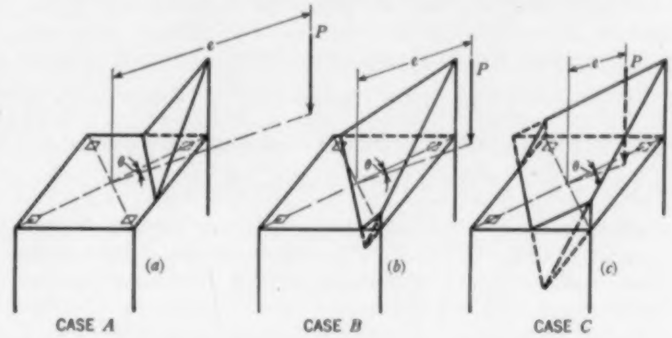


FIG. 2. SQUARE SECTIONS SUBJECTED TO THRUST AND TWO UNEQUAL BENDING MOMENTS

two cases it can be found by writing the relations corresponding to Eq. 3 and solving for f_c.
Thus:

$$f_c = C_A\frac{P}{D^2};\; f_c = C_B\frac{P}{D^2};\; f_c = C_c\frac{P}{D^2} \dots\dots\dots\dots [9]$$

where

$$C_A = \frac{12k\cos 2\theta}{4k^3 + 3np\,(2k - \cos\theta)\cos 2\theta}$$

$$C_B = \frac{24k(\cos\theta + \sin\theta)}{12k^2 - 6(\cos\theta - \sin\theta)k + (\cos\theta - \sin\theta)^2 + 6np\,(2k - \cos\theta)\,(\cos\theta + \sin\theta)}$$

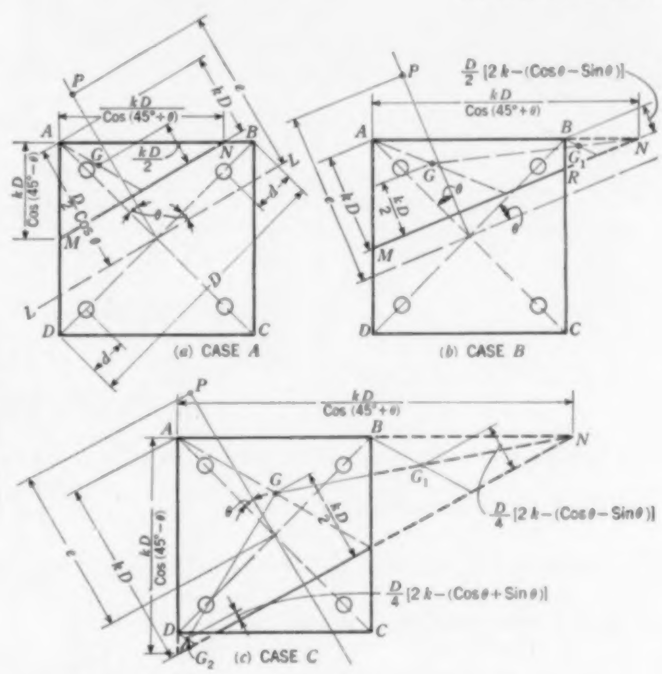


FIG. 3. ILLUSTRATING THE DERIVATION OF EQUATIONS FOR THE THREE CASES

$$C_c = \frac{12k\cos 2\theta}{-4k^3 + 12k^2\cos\theta - 6k + \cos\theta(1 + 2\sin^2\theta) + 3np(2k - \cos\theta)\cos 2\theta}$$

In all three cases the maximum stress in the tensile reinforcement is

$$f_s = nf_c\left[\left(1 - \frac{d}{D}\right)\frac{\cos\theta}{k} - 1\right] \ldots\ldots\ldots\ldots [10]$$

A study of the variation of k as a function of the variables θ, $\frac{d}{D}$, pn, and $\frac{e}{D}$ will reveal that when $\frac{e}{D}$ becomes very small then the rate of change of k becomes very great, making interpolation inaccurate. For design purposes it is therefore recommended that k be expressed graphically as a function of the reciprocal $\frac{D}{e}$. This has been done in Figs. 4 and 5 for angles of eccentricity of $\theta = 0°$ and $\theta = 22^1/_2°$ and a ratio of embedment $\frac{d}{D} = 0.2$. It should be noted that the shapes of these curves change very little with variation of θ. As θ increases the curves move upward, a fact which makes interpolation comparatively rapid and accurate.

For a numerical example, let it be assumed that a column in a reinforced concrete building is analyzed in the two directions in space by the principle of continuity, and that this analysis gives P = 2,000 lb; M_1 = 3,400 lb-ft; and M_2 = 7,900 lb-ft. The column is 12 by 12 in. and is reinforced with four $^7/_8$-in. round bars placed 7 in. between centers. It is assumed that $n = 12$. Other quantities to be computed are $e = \frac{\sqrt{3{,}400^2 + 7{,}900^2}}{2{,}000} \times 12 = 51.69$ in.; $\frac{e}{D} = 3.047$; $\frac{D}{e} = 0.328$; $\tan(45° - \theta) = 3{,}400 \div 7{,}900 = 0.4304$; $\theta = 21°48'$; $\frac{d}{D} = 2.5 \div 12 = 0.2$;

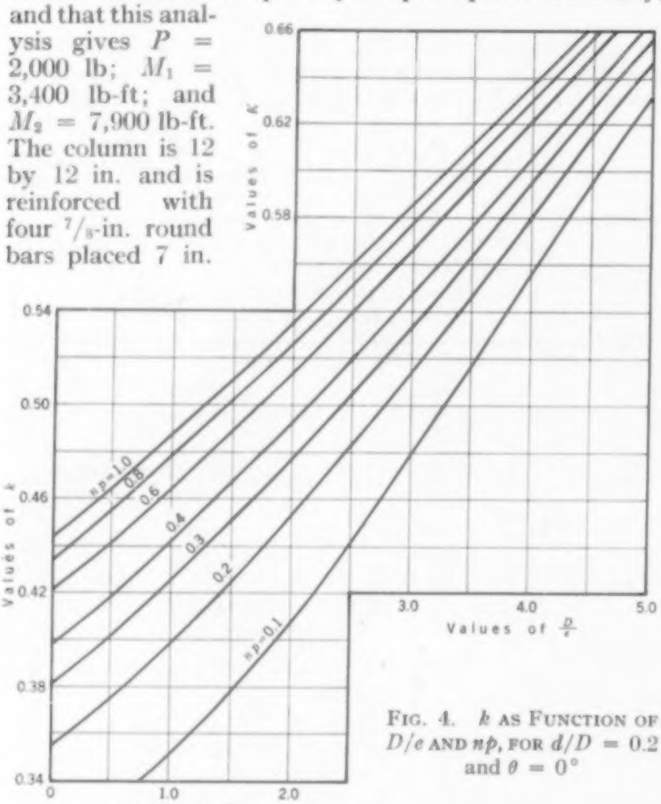


FIG. 4. k AS FUNCTION OF D/e AND np, FOR $d/D = 0.2$ and $\theta = 0°$

$$pn = \frac{2.41}{12 \times 12} \times 12 = 0.2 \ldots\ldots\ldots\ldots [11]$$

It is seen that the angle of eccentricity is very nearly the one for which Fig. 5 has been plotted. From this chart, the value of k for $np = 0.2$ is 0.328. As this value is between the limits given by Eq. 6 it is seen that the stresses are distributed over the column section in accordance with Case B. Hence the values from the preceding paragraph are to be substituted in Eq. 7, giving

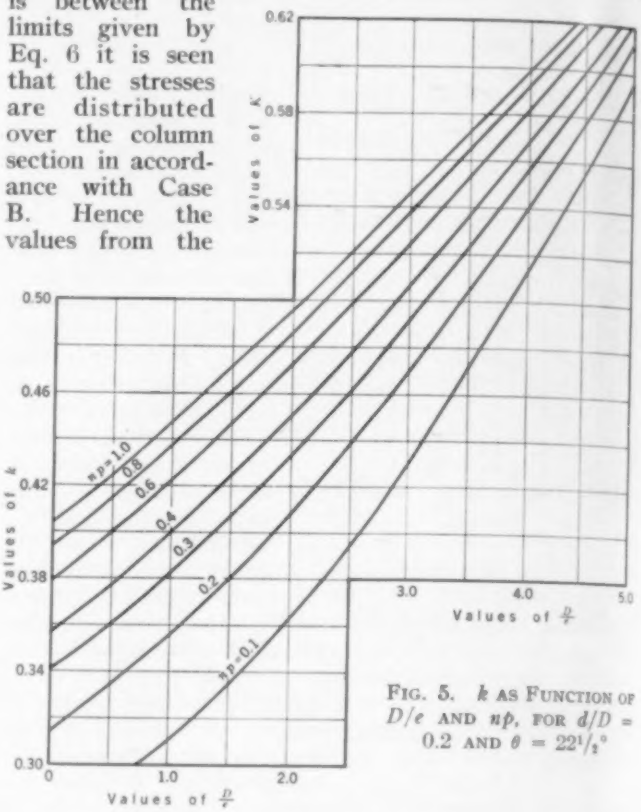


FIG. 5. k AS FUNCTION OF D/e AND np, FOR d/D = 0.2 AND $\theta = 22^1/_2°$

$$k^3 + 7.7483k^2 + 0.1419k - 0.9280 = 0$$

$$k = 0.33$$

Maximum compressive and tensile stresses (f_c and f_s) are computed from Eqs. 9 and 10. They are respectively 750 and 11,250 lb per sq in.

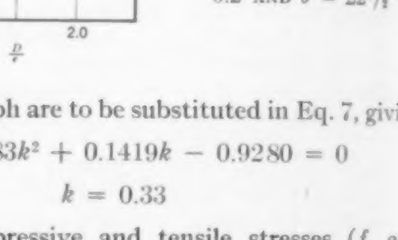
Unusual Topographic Survey

By JAMES S. ANDERSON

RESIDENT ENGINEER, WARREN AND VAN PRAAG, INC., CONSULTING ENGINEERS, DECATUR, ILL.

IN the course of a surveyor's work, there occasionally arises an unusual job for which ordinary methods of procedure are not only impractical but excessively expensive. Such was the type of work we recently encountered in making a very complete and accurate topographic survey of the grounds of a large estate, located among the ravines of Highland Park, Ill., along the steep bluffs of Lake Michigan.

The job called for accurate location and description of all trees, 468 in number, the majority in areas



WHITE CHALKLINE MARKING BASE LINE THROUGH UNDERBRUSH

covered with dense underbrush; the location of all drives, buildings, fountains, and utilities; as well as ground elevations for accurate contours, elevations at the base of each tree, and sufficient elevations for accurate 2-ft contours for a horizontal distance of 20 ft beyond the edge of a very steep bluff.

The Tree Caliper in Use

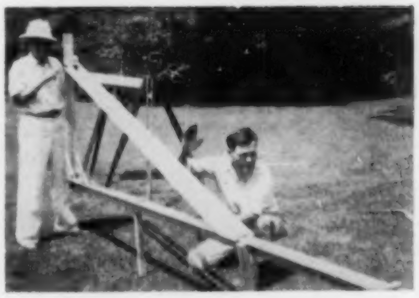
Because of the accuracy required, it was decided to lay out the entire estate in 100-ft squares. Through the more open areas two base lines, at right angles, were established, and auxiliary base lines located from these. At all corners 1 by 1-in. pegs were driven. It was found practical, also, to drive a numbered 1 by 1-in. peg at the base of each tree, both because of the accurate description, location, and elevation required for each; and because the trees were more often than not invisible to the man plotting, as we were prohibited from cutting any of the dense summer foliage.

In areas where dense underbrush reduced visibility to 10 or 15 ft, white chalkline was tautly stretched between corner pegs marking the various base lines. That made the maximum dimension from any base line 50 ft, which increased the accuracy of the survey and required less "plowing" through the underbrush and cobwebs for the chainmen.

Our method of procedure was to lay out a square with chalkline; locate all drives, walks, and buildings therefrom; drive numbered pegs at the base of each tree; make all east and west tree measurements, giving size and description; and then make all north and south measurements.

In determining tree diameters, "tree calipers," calibrated at 2-in. intervals, were found very useful. All measurements were taken waist high, or 36 in. above the ground, considerably above possible root deformations. Two diameter measurements at right angles were made for each tree and the average measurement used.

In determining elevations along the bluffs, it proved extremely difficult and often impossible to obtain accurate horizontal and vertical measurements, as the slopes varied from 45 to 85 deg. To eliminate this difficulty the "bluffometer" was constructed. It consisted of a 25-ft arm calibrated in feet to record the horizontal distance beyond the bluff edge, with a plumbbob attached to a tape operated by a small hand crank for determining the vertical distance to the slope from the end of the arm.



"Bluffometer" in Position on Level Pegs

In operating the "bluffometer" the following procedure was followed: At locations where elevations were to be taken, usually at 25-ft intervals between 100-ft base lines, two pegs 5 ft apart, one at the bluff edge, were driven to the same elevation. Usually a number of these could be driven from one instrument set-up. The "bluffometer" was then set on these stakes, the horizontal arm being necessarily level, and vertical distances were recorded for 2-ft horizontal intervals.

All data were plotted in the office from the plane-table notes, using a large scale. This aided the customer greatly in the location of proposed new buildings and relandscaping of the entire premises. It was found practical to leave the tree pegs for the use of the landscapers as an aid in location and identification.

"Bluffometer" in Operation

Thus, by the use of pegs, chalkline, "tree calipers," and "bluffometer," a job that might easily have been tedious and expensive was made economically rapid, accurate, and above all, interesting.

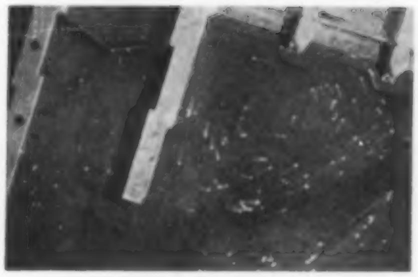
Photographic Technique for Recording Direction of Surface Currents in Models

By C. J. Posey, Assoc. M. Am. Soc. C.E.

Assistant Professor of Hydraulics and Structural Engineering, Institute of Hydraulic Research, State University of Iowa, Iowa City, Iowa

The direction of the surface currents in hydraulic models is frequently studied by observing the action of particles of confetti scattered upon the water surface. If it is desired to make a record of certain flow conditions, a photographic time exposure may be taken. The bits of confetti show as streaks in the photograph, the length of the streaks being proportional to the velocity and the length of the exposure. Unfortunately, however, the flow pattern is often complicated, and it may be difficult to tell which way along the streak the particle of confetti was moving. This difficulty is obviated by the new technique described herein.

The time exposure is started as before, but just before the camera shutter is closed, a flash bulb is set off. This



TIME EXPOSURE, FOLLOWED BY FLASH, PRODUCED THIS PICTURE, MAKING IT POSSIBLE TO RECORD DIRECTION AS WELL AS SPEED OF FLOW

puts a bright head on the downstream end of each streak, removing any uncertainty as to the direction of flow.

In actual use in the laboratory, some unexpected advantages were found. The flash bulb illuminates the details of the model, and the light during the longer part of the exposure need only be bright enough to insure that the streaks will show on the photograph. This not only saves in the amount of artificial lighting needed, but gives considerable latitude in its intensity. The accompanying photograph was taken inside the laboratory on a bright day, but without any artificial light except that from the No. 11 flash bulb, which was held about 8 ft from the area photographed. Panatomic film was used, and the exposure was approximately two seconds at f11.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Discussion on "Symmetric and Anti-Symmetric Loadings" Closed

TO THE EDITOR: The discussion in the July number of CIVIL ENGINEERING by C. M. Goodrich, M. Am. Soc. C.E., on my article on "Symmetric and Anti-Symmetric Loadings," in the April issue, leads me to fear that I did not make clear the fact that the relations expressed in my twelve conditions were applicable to any statically indeterminate structure having a plane of structural symmetry. They express obvious, though little used, relations between loads, reactions, slopes, and deflections on such structures and serve primarily to simplify the application of the moment-area, elastic weight, slope-deflection, moment-distribution, or least-work methods of analysis by providing equations of "symmetry" and "anti-symmetry" to be used in conjunction with the usual equations of static. As such, they supplement standard design procedures, but do not replace them. Since they require the solution of two force systems whose effect is equivalent to the single given system, they depend upon the theory of superposition, as Mr. Goodrich states, and they are not applicable when secondary effects render that theory void.

In his application of the method Mr. Goodrich, as has been pointed out by H. E. Warrington, M. Am. Soc. C.E., in a letter transmitted to me, has made an error in stating, "Since the tangents at G and H are parallel, the M/I areas total zero. . . . " There is no reason applicable to structures in general for the tangents at G and H being parallel, though the angular changes may be small and, as in this instance, the difference between them may be negligible. For other loadings or frame proportions Mr. Goodrich's formula might lead to error. It is true that for the case of anti-symmetrical loading the vertical deflection of G with respect to H is zero, hence that the sum of the moments of the M/I areas, taken horizontally about G, would be zero. This last statement assumes, of course, that the deflections of the frame due to the axial stresses in the members are negligible, an assumption normally made in the analysis of such structures.

Dayton, Ohio JOSEPH S. NEWELL

Engineers and Economics

DEAR SIR: In an address given on Engineers' Day at the Golden Gate Exposition, ex-President Hoover suggested that, since engineers are being blamed for so-called technological unemployment and since politicians and economists have been trying for years to remedy the economic situation without the slightest success, it is now time for engineers to uphold the truth and point out the only road that can possibly lead back to prosperity. The volume of goods and services produced is the index of prosperity, and engineers and scientists have contributed more towards increasing this volume than any other class of producers.

Engineers are accustomed to arriving at correct deductions from facts that are available, but few of them take enough interest in politics to apply this faculty to the analysis of economic problems, leaving that to economists and legislators. Because action and reaction are equal and opposite, a man cannot lift himself by his boot straps, yet leaders of the nation, with the approval of many of our educators, are attempting to restore prosperity by methods equally impossible. Furthermore, by referring to past history, it is apparent that these same expedients have been tried over and over again for more than a thousand years with the inevitable result that the currency becomes worthless and the kingdom, empire, or republic totters and falls.

The only way to raise the standard of living is to restore the freedom of the individual to produce as much or as little as he is capable of doing.

Few people seem to have a correct conception of money. Reduced to its simplest terms, all business and industry consists of the production, transportation, and exchange of goods and services. As the value of goods and services depends upon the value (as determined by supply and demand) of the labor of hand or brain that produced them, all industry finally consists of the exchange of labor for labor. Money is a token representing a unit of value to facilitate such an exchange; it has no value unless it can be exchanged for some product of labor that is of value, and, except by gift or theft, money can be acquired only in exchange for goods or services.

The value to a nation of the goods and services produced cannot be altered by changing the value of the currency in terms of gold. In 1937 the value of the total national production was 70 billion dollars, and that was the buying power of the nation. Computed at 1913 prices, this is only 43 billion. Prices and wages were higher in 1937. There was more money to spend, but the production per capita of goods and services was less than in 1913. Of the national income, $55^1/_3$ per cent was paid in the form of wages in 1913 and $67^1/_2$ per cent in 1937. Because of a monopoly of labor made possible by the enactment of certain laws, wages in some industries were pushed far above the level determined by supply and demand —from 100 to 200 per cent above the 1913 level—therefore the production of those whose incomes had not increased was sufficient to exchange for the production of only about half of those receiving the higher wages, with the result that 11 million were unemployed and therefore produced nothing.

Wages must be determined by the market value of the production; they cannot be set by law. The more each person produces, the more there is to exchange for the production of others. Some produce more than others, and it does not help the incompetent to limit the production of the competent. Furthermore, it is impossible to increase the production of the incompetent by law.

The causes of continued unemployment and unbalanced budgets are nothing mysterious, but just as recognizable as the force of gravity, and disaster is sure to follow unless the causes are corrected.

Grass Valley, Calif. ARTHUR B. FOOTE, M. Am. Soc. C.E.

A Collection of Comments on Work of TVA

To the Editor: The following is a brief digest of the discussion presented by the writer at the Chattanooga Meeting and, within the space limitations of Civil Engineering, touches on a few of the points discussed there. I regret that, within the scope of his subject, Mr. Parker could not have gone more deeply into certain phases of the TVA work, which have provoked considerable discussion. Aside from the engineering and construction aspects of the development, I cannot say that I am in full agreement with the principles upon which it has apparently been based, and there are some that I cannot reconcile.

For instance, I cannot agree with Mr. Parker's statement that the development of the Tennessee River is concerned with no single purpose. While it may be true that at least four ends will be served, as stated, and that the physical characteristics are adapted to the combination of some or all of these purposes, the great emphasis which has at all times been laid on the navigation and flood control phases of the development and the constant reference to the power development as being only "incidental," are apt to be misleading. It would seem from the course the development has taken that the main result has been a development for power, with navigation and partial flood control as by-products.

The matter of the development of the Tennessee River for navigation has turned out to be a highly controversial one. The U. S. Army Engineers, after many years of study, recommended from a purely navigation standpoint, a series of low dams costing approximately $75,000,000 (see House Document No. 328).

Apparently TVA plans for flood control involve several different problems: (1) the protection of the city of Chattanooga; (2) the general protection of the valley itself; and (3) "substantial contribution" to every major Mississippi flood. Here again there is apparently wide divergence of opinion among engineers as to the part the present development would play in any or all of these problems. There is a great preponderance of opinion to the effect that a flood control plan by reservoirs on the Tennessee devoted mainly to protection on that river has little or no value economically so far as the Mississippi is concerned, and that where the purposes of navigation, flood control, and power are combined there is a great deal of doubt among our leading engineers as to its workability.

On November 18, 1938, Ford Kurtz, M. Am. Soc. C.E., submitted the following statement to the Special Joint Congressional Committee: "It is my considered judgment that the TVA has not obtained adequate flood control on the Tennessee River and its tributaries; that even upon completion of all the eleven dams of the Unified Plan recommended to the Congress the TVA will not obtain adequate flood control on the Tennessee River and its tributaries; that the TVA could have obtained adequate flood control on the Tennessee River and its tributaries for $81,133,600—a small fraction of the $520,960,000 which the TVA Unified Plan will cost;..."

As to the economic soundness of the plan, I hesitate to agree with Mr. Parker. To be "economically sound" a project must not provide unnecessary surpluses. It would appear that navigation and power are being provided for far in excess of present, or immediate future, needs. It does not seem to me to be justifiable to spend some $300,000,000 for navigation and flood control alone (not including power plants) for what could be obtained for $155,000,000. Furthermore, low dams or flood control dams would not necessarily have precluded the development of power as needed. Also, a power development such as the TVA has carried out could not be attempted as an economically sound project by private capital. There must be a load for such power plants after they are built. In the case of the TVA development such load could be obtained only by the taking over of a market already developed by existing utilities and the taking over of these utilities bodily.

Referring to the subject of "force account construction," mentioned by Mr. Parker, there are some doubts as to whether this is the most economical method of construction. The writer has been on both sides of this question and realizes the arguments pro and con. There is always the question as to whether the organization, equipment, and all the other factors involved in such a specialized construction problem can be organized to perform such a job efficiently in a short period of time. There is always the temptation on force account work to overload the organization, and to spend money on refinements that in the final analysis add little or nothing to the job as a whole. Such projects as Hoover Dam, both of the Grand Coulee contracts, and parts of the Fort Peck Dam were contract jobs, and costs and results secured were, I understand, satisfactory.

In such a progressive program as has been followed by the TVA it would doubtless have been possible to secure excellent results and costs by contract, although in the case of the TVA development the reasons for doing the work by force account must have been carefully considered before a decision was reached. It is safe to say that engineers are as a rule prejudiced toward doing their work by force account, if possible.

A. C. Polk, M. Am. Soc. C.E.
Consulting Engineer

Birmingham, Ala.

To the Editor: The Tennessee Valley Authority and the work it is doing in the valley of the Tennessee River, described by Mr. Parker in the June issue, are perhaps the most interesting of the new functions recently undertaken by the federal government. Mr. Parker is to be congratulated, not only for having a clear logical plan for the complete development of the work, but also for presenting it without reference to its social, political, or economic implications.

Planning a series of construction operations, extending over a wide area and through a series of years, so that there is no confusion or waste of men or equipment, requires engineering ability of the highest type and, in my opinion, is perhaps the most notable engineering achievement of the Tennessee Valley Authority. Heretofore, dams have usually been designed and built for a single purpose, such as water supply, power, navigation, or flood control. It is relatively simple to design a dam having maximum efficiency for a single purpose. It is quite another matter to design a series of dams which, taken together, will efficiently serve all such purposes.

A series of seven new dams, together with the two previously existing dams, on the Tennessee River, provides for 9-ft navigation from the mouth of the river to Knoxville, Tenn., a distance of 650 miles. These dams create heads of from 39 to 65 ft each, and the addition of power plants assuredly cannot affect navigation even if they are operated at a 50 per cent daily load factor.

Not only are the main river dams high enough to provide power in addition to navigation, but each dam will permit a surcharge of the reservoir varying from 2 to 21 ft. These main river reservoirs are all large, so that a 5-ft surcharge provides storage capacity which can be used to reduce flood peaks during the flood period without interfering with either navigation or power. While the flow in the river is still high—but after the danger of floods on the Ohio and Mississippi rivers is past—the large storage made available by this surcharge may be allowed to fill, and the stored water can subsequently be used to augment the low flow. In particular, the enormous reservoir created by the Gilbertsville Dam has great possibilities in this respect.

From Coulter Shoals, the furthest upstream of the main river dams, each successive dam must pass not only an increased unregulated flow, but an increased regulated flow, and each successive dam can utilize a larger amount of water for power generation. It is interesting to see how this has been worked out, as shown by the following table:

Project	Mean Annual Flow, Cu Ft per Sec	Regulated Flow,* Cu Ft per Sec	Ultimate Turbine Capacity,† Cu Ft per Sec	Percentage of Mean
Coulter Shoals	...	...	...	...
Watts Bar	26,400	11,500	38,000	134
Chickamauga	38,400	15,000	30,700	80
Hales Bar	...	...	...	...
Guntersville	41,400	16,500	35,500	86
Wheeler	50,000	17,500	76,800	153
Wilson	52,000	18,500	65,500	126
Pickwick	55,000	20,000	58,000	105
Gilbertsville	64,000	24,500	43,000	67

* Based on storage available at Norris, Hiwassee, Santeetlah, and the Tennessee River dams as given in this table.

† Based on generator capacity at normal head and load conditions.

Stream-flow records of the Tennessee River are available for a period of 64 years. While this period is shorter than might be desired, it is long enough to establish the general characteristics of the stream flow. In a very general way, these stream-flow characteristics may be described as two years of very low flow in each ten-

year period. The years of low flow fix the amount of primary power that can be developed without an excessive, and little-used, steam reserve. Even large reservoirs cannot be used to supply this deficiency, since conditions of flood control require that the storage reservoirs be drawn down each year while the stream flow is likely to be deficient during two successive years.

It is thus seen that the characteristics of the river determine how much of the total power which can be generated will be primary and how much of it will be secondary. While the large amount of secondary power that can be generated is useless for public service, it has sufficient continuity to make it usable by industry, and provisions should be made to develop it.

J. P. GROWDON, M. Am. Soc. C.E.
Chief Hydraulic Engineer,
Aluminum Company of America

Pittsburgh, Pa.

TO THE EDITOR: Two discussions of the writer's paper, "The Construction Program of the TVA," were presented at the Spring Meeting at Chattanooga—one by J. P. Growdon and one by A. C. Polk, both Members Am. Soc. C.E.

Mr. Growdon has been very familiar with the work of the TVA, and his comments reflect an understanding of our engineering problems. His remarks are greatly appreciated.

The discussion by Colonel Polk appears to be largely based on various adverse statements and charges made in the course of recent controversies which have been of a political rather than an engineering character. Without wishing to prolong any of these controversies, it seems only reasonable to discuss a few principal items.

1. Typical of such claims are the estimates of $75,000,000 for a complete series of low navigation dams on the Tennessee River, and of $81,000,000 for a single-purpose flood control system (the so-called Kurtz plan). Both these estimates have been shown to be entirely inadequate, probably not more than half of the proper figures. This flood control scheme in particular is very misleading, since the costs proposed for certain projects are considerably less than the costs estimated by army engineers for the same sites. It makes no effective provision for control of floods in the Mississippi.

2. In the fourth paragraph of his discussion, Colonel Polk states: "There is a great preponderance of opinion to the effect that a flood control plan by reservoirs on the Tennessee devoted mainly to protection on that river has little or no value economically so far as the Mississippi is concerned, . . ."

The proposed contribution of the TVA to the control of Mississippi River floods will be through Kentucky Dam at Gilbertsville, which is located near the mouth of the Tennessee River, and consequently cannot be expected to benefit the balance of the Tennessee Valley directly. By means of this dam alone extreme flood heights at Cairo will be reduced by at least 2 ft.

The effect of this reservoir has been the subject of a remarkably thorough and elaborate analysis by our engineering staff, which has been verified by the following agencies: (1) a board of consulting engineers, consisting of L. L. Hidinger, E. W. Lane, and O. N. Floyd, Members Am. Soc. C.E.; (2) engineers employed by the Congressional Investigating Committee; and (3) the National Resources Committee.

3. Colonel Polk states that "the main result has been a development for power" and later remarks that "such load could be obtained only by the taking over of a market already developed by existing utilities, etc."

It is probably not generally appreciated that before acquisition of properties of the Tennessee Electric Power Company, the TVA power load had reached a peak of 407,000 kw. At that time the total hydroelectric generating capacity had just been increased to 444,000 kw, so that all major hydro units were in operation. At the present time TVA construction forces are expediting as much as possible the installation of additional units in order to keep up with the demand.

4. The use of force account for construction has had the numerous advantages which I have described, and doubtless some of the disadvantages mentioned by Colonel Polk. The best proof of construction efficiency is given by our records of unit costs, which are readily available.

5. The basic economy of TVA enterprises comes from the multiple-purpose use of single structures. That part of the system already completed is now being operated on an actual multiple-purpose basis. We believe that those engineers, who like Colonel Polk, have "doubts about its workability," should make a genuine attempt to see how it works.

T. B. PARKER, M. Am. Soc. C.E.
Chief Engineer, Tennessee Valley Authority

Knoxville, Tenn.

Structural Aluminum and Its Uses

TO THE EDITOR: In the August issue Messrs. Bleifuss and Fletcher have described the qualities of the alloys of aluminum most useful from the structural standpoint. These qualities make the material available for many uses where light weight, pleasing appearance, freedom from corrosion, and the strength of steel are a desirable combination. There are, however, certain limitations upon structural aluminum which must be kept in mind. It is inferior to steel in hardness and ductility. Its comparatively low modulus of elasticity must be recognized, and its temperature coefficient is relatively high. These characteristics somewhat hamper the use of the material in combination with other metals, such as steel. However, they readily permit the development of entire structures of aluminum, and combination structures have been successfully constructed with due attention to the above characteristics.

Uses made by the Tennessee Valley Authority of various grades of aluminum may serve to illustrate the place which this material may occupy in the work of a large construction organization. Passing by the aluminum paint—which is generally used on steel structures in the air, and to some extent under water—aluminum has been incorporated in various architectural features. These include large folding doors at the Norris and Wheeler power houses as well as other doors in these and other plants, window sash at Wheeler, handrailings, trim on generator housings, grilles on ventilating systems, letters on the exterior of buildings, and a number of lesser uses. In these cases, adequate strength, combined with pleasing appearance and freedom from corrosion and the consequent necessity of painting, has been responsible for the use of aluminum, even though the first cost was high.

In the electrical field, the high conductivity of the metal, combined with its lightness, has made it highly available. It is closely competitive with copper in many cases. The Authority has purchased many miles of aluminum transmission wire, and will do so in competition with copper when the price situation is favorable. Alternate bids are received on copper and aluminum bus bars and similar heavy conductors.

The combination of adequate strength, freedom from painting, and non-magnetic properties has led to the use of aluminum housing for the power leads from the generators in the power houses at Guntersville, Chickamauaga, and Hiwassee dams. For the same reasons, aluminum conduits are used in certain places.

Aluminum lighting fixtures, both interior and exterior, and reflectors have been used extensively. The reflectors are considered comparable with those of mirrored glass.

In construction plant, several interesting uses have also developed. On two projects, the Authority has been obliged to haul cement from rail to the job in tank trucks, nearly two million barrels being so transported. It was found that by using an aluminum tank instead of one of steel the load per truck could be increased from 55 to 61 bbl, an increase of 11 per cent. The increase of capacity made the extra cost of the tank well worth while.

On several jobs the heavy panel forms have been shifted by the use of A-frames made of structural aluminum. A typical frame weighs 140 lb and can handle loads of 3,000 lb. These can be shifted, set, and guyed very expeditiously, and have contributed to low costs in handling forms.

From these instances, it will be observed that there are numerous uses for structural aluminum. We would use more of it if it were cheaper. Aluminum costs three to four times as much per unit of strength as does steel, but there are frequent cases where this expenditure is justified. In fact, the metal must be regarded as one of the established materials of construction.

ROSS M. RIEGEL, M. Am. Soc. C.E.
Head Civil Engineer, Design Department,
Tennessee Valley Authority

Knoxville, Tenn.

SOCIETY AFFAIRS

Official and Semi-Official

Western Local Sections Meet

Enthusiastic Conference in San Francisco Attended by Representatives of 13 Sections

On July 25, 1939, the day just prior to the opening of the Annual Convention of the Society, representatives from each of the 13 Local Sections in the western part of the United States met in an all-day conference at the St. Francis Hotel in San Francisco under the leadership of James W. Follin, chairman of the Society's Committee on Local Sections. About half of the Sections were represented by their presidents, others by their secretaries, and still others by both president and secretary. Discussion was pointed, active, and rapid. Everyone present had something to say about phases of the general subjects, "How Can Local Sections Be Made of Greatest Benefit to the Profession?" and "What Duties and Functions May Properly Be Turned Over to Local Sections?"

In his address of welcome, Frederick H. Fowler, president of the San Francisco Section, mentioned his inability to conceive of a situation where there was no Local Section, because when he became a Junior in the Society 33 years ago, the San Francisco Section, the first Section to be officially authorized, was a going concern and he became a member of it. In his opinion the proper organization of a Section is one of the most important things in the life of the Society. He could not see how anyone could get the maximum benefit from the Society without being a member of a good live Section, that brings together fellow engineers for discussion of problems, for social intercourse, and for all the other things that make professional engineering worth while.

Junior Forums for Self-Improvement

The first specific topic for discussion concerned the Juniors and was introduced by H. Macy Jones, president of the Los Angeles Section, who explained the organization of the Junior Forum of the Los Angeles Section and its accomplishments during the past eight years. "The Junior Forum idea," he said, "probably originated in the Los Angeles Section and had its first application there in 1932. It was the brain child of Harry W. Dennis."

"The Juniors in Los Angeles," continued Mr. Jones, "hold their monthly meetings at 5 o'clock on the night of the regular Section meeting, which sits down to dinner at 6:30 p.m. The forum is self-operating, has its own officers, and arranges its own programs but it is the duty of the president of the forum to give a short synopsis of the forum program to the Section.

"The Junior Forum bears the same relation to the Society that the junior college does to the university system. The better the junior college student is trained in the preparatory fundamentals and the clearer his conception can be made of the ultimate use of his collegiate education, the more benefit he will gain from his university work. And likewise the young graduate entering the Society as a Junior will get more benefit from the Society, will be a more enthusiastic, more interested and, later on, a more valued corporate member if his introduction into the Society is under favorable and properly prepared circumstances.

"The Junior Forum offers a number of opportunities for self-development and professional growth. It is an added incentive for the young man to become affiliated with the Section, for in the forum he can meet with men of his own age and experience. This type of meeting develops early and intimate friendships, many of which will last for a lifetime.

"The forum offers another opportunity in developing self-reliance and confidence. It should be the obligation of every member to address his organization on some subject with which he is familiar, and to take part in discussion. This readily develops his ability to stand on his own feet and make clear, concise, and factual statements. Since the forum is self-governing it provides, also, a number of opportunities for organization and administrative experience.

"We earnestly urge young graduates to join our Society and the Section, but if we are not careful we may thoughtlessly neglect them once they are in. The forum is a constant reminder to the members of the Section, both individually and collectively, that

Local Section Officers and Others in Attendance at Conference in San Francisco

Front Row (Left to Right): Thomas C. Adams, President Utah Section; Thomas E. Stanton, Jr., Director Am. Soc. C.E.; F. H. Fowler, President San Francisco Section; J. W. Follin, Chairman Committee on Local Sections, Am. Soc. C.E.; A. N. Talbot, Past-President and Honorary Member, Am. Soc. C.E.; Donald H. Sawyer, President Am. Soc. C.E.; George T. Seabury, Secretary Am. Soc. C.E.; R. B. Wright, President Oregon Section; Frederick W. Panhorst, President Sacramento Section; Thomas M. McClure, President New Mexico Section.

Back Row (Left to Right): Walter E. Jessup, Field Secretary, Am. Soc. C.E.; Paul S. Bailey, President Colorado Section; H. T. Person, President Wyoming Section; H. Macy Jones, President Los Angeles Section; C. Wayland Capwell, Secretary-Treasurer San Diego Section; C. B. Sadler, Vice-President, San Diego Section (in front of Mr. Capwell); H. E. Phelps, President Spokane Section; R. M. Harris, President Seattle Section; Wells H. Ashley, Secretary-Treasurer Tacoma Section; J. I. Ballard, Vice-President, San Francisco Section; Theodore Neuman, Secretary-Treasurer Sacramento Section; W. T. Wishart, Secretary-Treasurer Arizona Section; C. B. Neill, Past-President San Diego Section; P. Beermann, President San Diego Section.

the Junior is present. The assignment of the Junior Forum Adviser, a corporate member of the Section, is important. He should be a man of excellent personal and professional attainment, one who can secure the confidence of the Juniors themselves, and one to whom they would willingly go for advice and counsel.

"Now, it does not appear to some of us that the Society has done all that it should for the Juniors through the Junior Forum. The forum itself offers advantages which contribute particularly to the professional improvement of the Junior and somewhat to his social status, but there remains for the Society the duty of taking effective steps to improve the economic status of the engineer, particularly the young engineer, because without appropriate economic status the professional and the social status become of secondary importance."

Speaking on the function of Juniors in Local Section work, President T. M. McClure, of the New Mexico Section, pointed out that in considering the use of a component of a society, it is well to take stock of the aims and objectives of that society and the purposes of membership in it. "In the American Society of Civil Engineers the meaning of membership is threefold," he said, "first, service in the advancement of the engineering profession; second, service to mankind; third, the return of that service to the member giving it in proportion to the service he renders. In order for a Section to attain these objectives, all its members, including its Juniors, must work toward them."

> *"In the American Society of Civil Engineers, the meaning of membership is threefold: first, service in the advancement of the engineering profession; second, service to mankind; third, the return of that service to the member giving it in proportion to the service he renders."*
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> *"With over 12,000 corporate members of the Society, all of them more or less in responsible charge, it would seem that by united action and unity of thought, a good many of our salary problems could be quickly and amicably settled."*
>
> *"Local Sections should do more for the men in their vicinity. An engineer who is out of work should look to his Local Section for every possible aid in helping him to secure another position."*

According to a show of hands, 5 of the 13 Sections represented were sponsoring Junior Forums—Los Angeles, San Francisco, Utah, Sacramento, and Colorado. Dr. Thomas C. Adams, president of the Utah Section, spoke of the organization during the year of a Junior Forum in Salt Lake City with monthly technical meetings alternating with the Section's monthly meetings. This group is attempting to do two specific things: first, through increased acquaintanceship put themselves in a better position to be placed in employment adequately compensated; and, second, to improve their technical and professional ability so as to improve civil engineering in its professional aspects and individually to become more competent to render the service demanded of a civil engineer. J. I. Ballard, vice-president of the San Francisco Section, stated that the San Francisco Junior Forum meets bi-monthly in a dinner meeting. Thirty-five or forty Juniors attend. A current topic is presented and discussed for half to three-quarters of an hour, after which a Junior previously appointed as a referee summarizes the remarks that have been made and indicates the consensus of opinion of the group. This is followed by the speaker of the evening—usually a Junior—in a half-hour presentation of some phase of his own work. In the Wyoming Section, whose members are thinly scattered over a big state, the Juniors are especially encouraged to take an active part in the Section's work. Two Juniors serve on the board of directors, one as junior assistant to the president, the other as junior assistant to the secretary.

Dr. Charles F. Scott, president of the National Council of State Boards of Engineering Examiners, observed that in college the engineering student has his professors to guide him in the right direction, but after graduation he is on his own resources. Here the professional societies are functioning in providing for the continuation of the training of recent graduates and in guiding them into the kind of experience they should be getting.

Local Enforcement of Registration Laws

Over a period of years the registration of professional engineers has become almost universal. Only a few states now are without registration laws in some form. In discussing the enforcement of these registration laws in each state, Prof. H. T. Person, president of the Wyoming Section, and a member of the Wyoming Board of Engineering Examiners, expressed his feeling that Local Sections can and should play an important part. "There are some common problems of enforcement," he said, "the solution of which would be greatly facilitated by an active and aggressive participation by our Local Section. First, the Local Section can do much to keep the Registration Board informed of cases of illegal practice. Most of our boards do not have the funds to hire a special police officer to ferret out cases of illegal practice and have to depend on local, county, and state officials to keep them informed of such cases. These local officials, because of other duties and because they lack qualifications, determine whether or not a man is qualified to practice engineering, and are about 100 per cent ineffective from the enforcement standpoint. The Local Section's active registration committee could, without an undue amount of effort on any individual's part, report cases of illegal practice.

"Also a Local Section could help in obtaining modifications of the registration law. And the third way in which it could help is in conducting an educational program to sell engineering registration to the public and to the profession. This is of much more importance than the sharpest teeth that can be put into the registration law. To sell such a law to the profession, the Local Section could sponsor meetings at which problems of its enforcement could be discussed.

"Until about five years ago, of 70 engineers in the Wyoming Highway Department in responsible charge of work, less than 10 per cent were registered. Members of the Board of Engineering Examiners of Wyoming discussed this situation and as a result of this discussion—we might call it an educational program—today every engineer in responsible charge of work with the Wyoming Highway Department is registered.

"This program has changed our coverage of the engineers qualified to be registered in Wyoming from 50 per cent five years ago to over 90 per cent today. The other 10 per cent are those employed by the federal government and are exempt.

"The fourth way in which a Local Section could help a board of engineering examiners is in the matter of a revocation proceedings—for fraud, deceit, moral unfitness, and incompetence. In order to revoke a man's license there has to be a complaint filed against him. The question is always brought up as to who should initiate the proceedings by filing the complaint. It has been held by a number of lawyers in Wyoming that the board constitutionally is unable to initiate action, since in that case it would serve both as prosecutor and judge.

"So in Wyoming our board would appreciate a strong Local Section to help it in initiating revocation proceedings. We find that as far as revocation proceedings are concerned in Wyoming, we can get all kinds of advice, but very little assistance."

"Alabama's engineering registration law is but four years old," stated Col. A. C. Polk, of the Alabama Section and chairman of the Alabama Board of Registration. "Ninety per cent of our cases of violation are due to ignorance of the law which a polite letter from our Board's secretary will cure. In the other 10 per cent, we have great difficulty in getting engineers to furnish enough information to prosecute. Engineers must take a more active part in the enforcement of these laws, which are their laws, if we are to have real enforcement."

Having been active on the Legal Procedure Committee of the National Council of State Boards of Engineering Examiners for several years, Prof. C. C. Knipmeyer of Indiana felt that "When the public and the engineers themselves see that registration is a real safeguard for the public and for the profession, then enforcement will come along very easily." H. Macy Jones, secretary of the California Registration Board for Civil Engineers, took issue with this viewpoint and expressed his belief that if engineers are to be registered under their law, persistent violations of the law by incompetent men must be vigorously and definitely prosecuted if registration is to be effective. "Nevertheless, a prosecution does not mean a persecution," said Mr. Jones.

Speaking of the Local Section's part in enforcing registration laws locally, Prof. J. H. Dorroh, of the New Mexico Section, and chairman of the Society's Committee on Engineering Registration, explained that the Board of Direction had asked each Local Section of the Society to appoint committees to cooperate with

local registration boards. He appealed to these Section committees to become a bit more active in assisting the local boards, to effectively use the machinery that the Society has set up.

In summing up the discussion on registration, Chairman Follin observed, "There are two important lessons that the American Medical Society has taught us in the matter of licensing doctors: First, it is probable that respect for medical licensing has been brought about by vigilant prosecution at the right time; and, second, the enforcement of the law is largely a matter incumbent upon the profession itself in gathering the evidence needed and in bringing about the actions which are necessary. When that is done it takes the responsibility off the individuals' shoulders and puts it on the profession at large, where it belongs."

"*The Sacramento Section is interesting itself in organizing a speaker's group, furnishing men available on call to appear before service clubs and local organization to present civil engineering subjects.*"

"*The Junior Forum bears the same relation to the Society that the junior college does to the university system.*"

"*There are some common problems of registration law enforcement, the solution of which would be greatly facilitated by an active and aggressive participation by the Local Sections.*"

"*Selling engineering registration to the public and to the profession is of much more importance than the sharpest teeth than can be put into the registration law.*"

The Society's Salary Schedule

In the February issue of Civil Engineering was presented a preliminary schedule of salaries published by the Society's Committee on Salaries for local consideration, constructive criticism, and suggestions for change so as to more properly fit local conditions. Features of that schedule were discussed, notably by Paul S. Bailey, president of the Colorado Section, and John C. Hoyt, of Washington, D.C. [See the September issue of Civil Engineering for the salary schedule as adopted by the Board of Direction at its session on July 25, 1939, while the Local Section Conference was in session.—Editor.]

W. T. Wishart, secretary of the Arizona Section, noted that of its members 80 per cent are in some governmental service—national, state, county, or city. Nearly half hold civil service positions. "The Local Section's salary committee is helpless in this situation," he stated. "It is distinctly a problem for the Society's Committee on Salaries and the concern of all Local Sections coordinated and cooperating with the Society's committee. There is hope, however, in the face of a recently published account of WPA wage scales, that civil service bureaus may be brought up to WPA rates. Studies of non-civil service groups will show that graduate engineers, rated as draftsmen, transitmen, and designers, are nearly equaled by stenographers, and are topped by sub-head clerks and chief clerks.

"With over 12,000 corporate members of the Society, all of them more or less in responsible charge, it would seem that by united action and unity of thought of this huge group, a good many of our salary problems could be quickly and amicably settled. Engineer employers are, however, closely related to the Scotch Presbyterian on expense account, with the Scotch instinct overcoming the Presbyterian conscience.

"Associate Members in responsible charge must recommend wherever possible the employment and advancement of Juniors. Members who are employers should feel bound to adopt the schedule wherever possible. Local committees should insist that skilled engineers be rewarded with compensation at least equal to that of skilled labor. A local educational campaign, with a paid full-time secretary, is worthy of consideration. Sections should take greater interest in community affairs and concentrate on placing engineers in key positions.

"In Denver there are probably 1,000 engineers who would be affected by this salary schedule," said Paul S. Bailey, president of the Colorado Section. "Our first approach should be to department heads in state and city employment. It will naturally follow that the U. S. Civil Service Commission will be influenced by the analyses and recommendations of the heads of these departments."

The San Diego Section is already cooperating with a local civil service group to establish proper qualifications and reasonable salaries for various civil engineering positions, according to Paul Beermann, president of that Section.

Effective Program of Local Publicity

"The effectiveness of a program of local publicity," said Clayton B. Neill, past-president of the San Diego Section, "is largely if not entirely dependent upon convincing engineers that there is value in publicity. The engineer has always taken the attitude that his works should speak for themselves. This is as it should be. His works endure; he lives with them; and they must be well conceived. But in an age of advertising, publicity, and salesmanship, is it enough for the engineer just to let his works speak for themselves? He is a competitor now more than ever before, and although his nature and training are all conservative, he should enter this field with honest publicity. Not only will the result accrue to his own personal benefit, but there will be a wider public acceptance of his ideas and he will then have the opportunity to be truly symbolic of orderly development for the safety and benefit of mankind.

"The field of newspaper notices and reports of meetings and engineering functions has been thoroughly covered by the excellent instructions which have been issued from Society Headquarters.

"However, there are other ways in which the engineer can publicize his works. There are engineering works in each community, for example, built by the earliest settlers. Local Sections might undertake to write up for publication semi-historical narratives of the first examples of engineering practice in their district. There was a time when the government surveyors were laying out section lines. Many interesting tales about that work could be told. Some of these could compare that work with modern surveying and mapping as undertaken by the U. S. Geological Survey. Maps are used by everyone. Their preparation would make an interesting story.

"In each community there is always a subject in which the local people take great interest. In semi-arid country it is often water supply. One needs only to give newspapers two or three little articles on that subject and he has the reporters continually asking him for other material."

Agreeing that the conventional characteristic of civil engineers is modesty, Roy M. Harris, president of the Seattle Section, stated that as a profession we will continue to occupy a back seat in public esteem and remain undercompensated in comparison with other professions until our basic ideas regarding proper publicity are changed. He said, "I believe it is a recognized fact that civil engineers, as a body, are an inarticulate group. If civil engineers lack the ability to speak clearly, write clearly, participate in civic affairs, and in other ways make themselves known as an outstanding profession in the public eye, it is because of inadequate training in the essentials and subjects that result in well-educated individuals. The values to be derived from a plan requiring five or six years of college, which will allow for more public speaking, English, economics, political science, and other subjects pertaining to the liberal arts, would materially aid in reducing the need for publicity. But in the meantime, let us make good use of the press, the radio, and the speaker's stage."

A general discussion of the problem of interesting the newspapers in civil engineers and their service to make the community a better and more comfortable place to live in, revealed the difficulty encountered in San Francisco, Los Angeles, and other large cities to obtain space in the dailies. The Sacramento Section is interesting itself in organizing a speaker's group, furnishing men available on call to appear before service clubs and local organizations to present civil engineering subjects. Notwithstanding the experience of the San Francisco Section, opinion seemed to support the idea that a program of public education by the Society or by the Sections may properly be conducted by a professional writer and may warrant a modest expenditure of money.

In summing up a very intensive and instructive series of discussions on ways and means, Chairman Follin said:

"There isn't another profession that is so close to community life as is civil engineering. Civil engineers have the opportunity as no other branch of engineering, as no other profession has, to build up respect for its art and for its capable and competent members in the minds of the public. As this respect is built up so will the entire profession be built up. It will be easier to establish salary standards that are commensurate with the importance of

the work civil engineers do for a community; easier to get respect for registration laws; and easier to get enforcement."

Civil Service for Civil Engineers

In introducing the subject of the establishment of a civil service or merit system for civil engineers in city and state employ, R. B. Wright, president of the Oregon Section, reviewed the history of this system. In smaller cities civil service has grown slowly, less than half the employees in cities of less than 50,000 population being under civil service; while in cities of over 100,000, the figure is 80 per cent. Only 14 states operate under a merit system and only 8 counties maintain their own civil service agencies, 4 of them being in California. Thus the field is far from covered in the lesser governmental units.

A specific example of how a Section can help its civil service members was related by J. I. Ballard, vice-president of the San Francisco Section:

"The subject of civil service and its relation to the civil engineering profession naturally divides itself into two phases: (1) the continued encroachment of civil service engineering organizations into the field of the private engineer, and (2) interest in improving the professional, financial, and social status of those engineers who are now working under civil service regulations.

"Several years ago the Section, at the request of our members in the city employ, appointed a committee to study the standardization of engineering salaries and recommend revised limits within existing classifications. The report received the subsequent approval of the San Francisco Engineering Council, and with this additional backing was personally presented to the Civil Service Commission of San Francisco. After an extended period of consideration the entire matter of salary standardization was referred to the voters by the mayor for final approval. The general publicity on the subject related principally to proposed salary increases in the higher administrative brackets, and the fact that many clerical positions had standards already very much above corresponding ones in private employ. The logical and deserving standardization of engineering salaries became the tail on the dog, and was lost in the public's concern over salary increases and its disregard for the justice of salary standardization. Such a subject very definitely belongs to the province of the Civil Service Commission, rather than for uninformed public voting.

"At present the local situation is relatively unchanged and the lack of adequate standardization in municipal engineering salaries remains a problem of direct concern to the San Francisco Section. Even though civil service principles are in operation in any local governmental organization, there may be ample opportunity for the Sections to work for the advance of professional recognition."

Theodore Neuman, secretary of the Sacramento Section, reiterated that Local Sections have an obligation and a duty to present the Society's progressive classification and salary standards to civil service examiners in their communities. Chairman Follin summarized the presentations by observing that the conference seemed to agree that civil service for civil engineers is desirable because it provides a list of qualified men from which appointments are made; it provides a means of advancement in the system, in recognition of services performed; it provides tenure of office through a change in political control; and should keep political considerations out of appointments.

Local Committees on Professional Objectives

Like a number of other Local Sections, the Sacramento Section, said Mr. Neuman, has appointed a local committee on professional objectives. In studying how the Section's committee could function without overlapping, he said, the six principal committees of the Section dealing with the improvement of the status of the professional civil engineer—Public Relations, Legislative, Juniors, Engineering Salaries, Publicity, and Entertainment—are all cooperating. To coordinate the work of these committees he suggested that the chairman or a member of each of them can be a member of the Section's Professional Objectives Committee which would meet quarterly to develop and discuss suggestions of merit for inauguration locally, to forward them to the Society's committee for review, and in turn receive and disseminate to the Local Sections the constructive ideas of the Society's committee.

Local Employment or Placement Service

Pointing out that the Engineering Societies Employment Service maintained offices in New York, Chicago, and San Francisco, Wells H. Ashley, secretary of the Tacoma Section, said that they are too far removed from a large group of members to be especially helpful. "Local Sections should do more for the men in their vicinity. An engineer who is out of work should look to his Local Section for every possible aid in helping him to secure another position. It would be well to have it known to employers that the Local Section can furnish him with names of qualified men to handle his work. Further, our own Sections need not work alone in a given vicinity. No doubt, sections of the other Founder Societies would be very glad to cooperate in establishing employment services for all engineers. Our Society has developed a fine standing technically, but it does need this human touch. These local employment services are needed by both unemployed and misplaced engineers and they will help to build up the Society."

At this point in the day's deliberations, President Donald H. Sawyer was enabled to leave the Board of Direction, over whose sessions he had been presiding. He was introduced and enthusiastically received by the conference, and spoke informally on the general topic of what duties and functions might properly be turned over to Local Sections. In conclusion, he called the attention of Local Section officers to three points in particular: "First, to make a more conscious effort to hold the members that you now have within your ranks, and to get new members; second, to consider for the moment whether or not you can be trusted with greater responsibility in inducting members into the Society; and third, to spread the gospel that will come to you from the salary schedule adopted today in assisting in raising the estate of our young men."

Transactions, Volume 104

With the October Proceedings, members will receive their paper-bound copies of the annual volume of Transactions. Those who preserve their copies in special cloth or half-leather bindings will receive them in separate cartons as soon as the binding is complete. The volume includes papers published in Proceedings between September 1938 and September 1939, inclusive, with all discussions and closing discussions.

In sheer size, Volume 104 will exceed all volumes following No. 83, published in 1920. It contains 2,096 pages, 342 of which have not been published previously. Readers who follow discussion in Proceedings, therefore, will wish to read the following contributions, published directly in Transactions:

"Beam Constants for Continuous Trusses and Beams," closing discussion by George L. Epps.

"Solution of Equations in Structural Analysis by Converging Increments," closing discussion by George H. Dell.

"Trunk-Line Highways in Metropolitan Areas," closing discussion of the paper in the symposium, "Motor Transportation—a Forward View," by Leroy C. Smith.

"Reconstruction of a Pier in Boston, Massachusetts, Harbor," discussion by John Ayer and closing discussion by Charles M. Spofford.

"Energy Mass Diagrams for Power Studies," closing discussion by John W. Hackney.

"Mechanical Structural Analysis by the Moment Indicator," closing discussion by Arthur C. Ruge and Ernst O. Schmidt.

"Lateral Earth and Concrete Pressures," closing discussion by Lazarus White and George Paaswell.

"A Theory of Silt Transportation," closing discussion by W. M. Griffith.

"Siphons as Water-Level Regulators," closing discussion by J. C. Stevens.

"Frontiers of Engineering," address at the Annual Convention, San Francisco, Calif., July 26, 1939, by Donald H. Sawyer, President, Am. Soc. C.E.

Interstate Water Problems: Final Report of the Committee of the Irrigation Division on Interstate Water Rights.

As is customary, the volume closes with the professional memoirs of deceased members. A limited number of reprints of each of these are available for free distribution to relatives and intimate friends.

The Average Local Section

The "average American family" pictured from time to time by statisticians is a most fascinating concept. Associated with it are a number of peculiar and rather uncommon phenomena, like its fractional children (2.3, or some such number), and its penchant for living in 3.37 rooms and taking in 1.1 boarders. Comes now the newest product of the slide rule, the average Local Section, and its make-up and activities prove equally unusual and interesting. Figures have been computed from data in the progress report of the Committee on Local Sections, presented to the Board of Direction at its July 1939 meeting.

On December 31, 1938, the average Local Section had 216.3 members (as allocated by the Society), of whom 97.5 were active (as indicated by their having paid dues or otherwise subscribed to the Section's constitution). Its total income from all sources in 1938 was $515, of which $311 was in the form of assigned funds remitted from national headquarters. This income had been spent as follows:

For stenographic services, postage, stationery, general printing, meetings, and entertainment	$227
Dinners and luncheons for guests, students, and others	43
Technical publications and Section year book	46
Payments to local societies	24
Support of activities of Juniors of the Section	6
Support of student activities and Junior prizes to members of Student Chapters	33
Official travel of Section officers	19
Work of miscellaneous committees	25
Secretary's honorarium	41
Meetings of the Society	6
Other expenditures, and amounts deposited to reserve accounts	45

Guiding the destiny of the average Local Section were 4.4 officers, assisted by 7.23 committees with a combined personnel of 27.3 members—more than a fourth of the total active membership. The Section held 8.8 meetings during 1938, with an average attendance of 60 persons. One of these meetings was held jointly with students and another was a joint activity of the Section and another society. Also included in the list of meetings were 0.51 of an inspection trip and 0.24 of a social gathering.

The Section gave considerable moral, as well as financial, support to the 1.9 Student Chapters ir its area. Financial support consisted of Junior memberships in the Society and other prizes in the form of cash, books, medals, scholarships, badges, and certificates. It invited the students to a number of its meetings, and paid part of their dinner expenses.

Last but not least, the average Local Section has 0.11 of a Junior Forum, which carried on a separate and extensive program of its own throughout the year, under the general guidance of a special committee of the Section.

Civil Engineering Cuts to Be Destroyed

In accordance with its usual custom the Society will destroy cuts from Volume 8 of Civil Engineering—that is, 1938—at the end of the current year. Those wishing to have any of these illustrations (cuts for the covers and pages of special interest are available only as a loan) should notify Society Headquarters before December 31, 1939. The only charge will be the cost of forwarding by express or parcel post. Preference will be given to the authors of the articles in which the illustrations appear—after that requests will be filled in the order received.

Board to Meet October 6–7

The Board of Direction will hold its regular fall meeting on October 6 and 7, at Society Headquarters in New York. In accordance with constitutional provisions, one important item of business at this session will be the selection of the official nominee for President.

Appointments of Society Representatives

William P. Creager and Frederick W. Scheidenhelm, Members Am. Soc. C.E., have been appointed to represent the Society on the Sectional Committee on Rating of Rivers of the American Standards Association

Walter S. L. Cleverdon, M. Am. Soc. C.E., has been appointed the Society's representative on the American Standards Association's newly established subcommittee to prepare a code covering plumbing.

E. N. Noyes, M. Am. Soc. C.E., will represent the Society at the inauguration of Dr. Homer Price Rainey as president of the University of Texas at Austin, Tex., on November 18, 1939.

R. L. Sackett, M. Am. Soc. C.E., served as the Society's delegate at the 47th annual meeting of the Society for the Promotion of Engineering Education, which was held at State College, Pa., June 19 to 23, 1939.

Harold E. Wessman, M. Am. Soc. C.E., has been reappointed to represent the Society on the Research Procedure Committee of the Engineering Foundation for the term, October 1939 to October 1940.

Forecast for October "Proceedings"

General Wedge Theory of Earth Pressure
By Charles Terzaghi, M. Am. Soc. C.E.
The definition of a broader concept than the original Coulomb theory, as applied to the timbering of cuts or tunnels.

Sewage Disposal Project of Buffalo, New York
By Samuel A. Greeley
The story of an important construction program, including detailed costs "for the record."

The Role of the Engineer in Air Sanitation—A Symposium of Two Papers

A General Survey
By Earl B. Phelps
A concise, well-defined statement of problems facing sanitary and public health engineers in modern society.

Typical Problem in Industrial Sanitation
By J. J. Bloomfield
Demonstrated by detailed reference to a survey of the hatters' fur industry.

Functional Design of Flood Control Reservoirs
By C. J. Posey, Jun. Am. Soc. C.E., and Fu-Te I
A simplified study of the relation between the storage space that must be provided for flood control and the corresponding reduction of the flood peak.

Effective Moment of Inertia of a Riveted Plate Girder
By Scott B. Lilly and Samuel T. Carpenter
Tests leading to the derivation of a formula for effective moment of inertia, nearly coincident with the gross moment of inertia.

An Improved Method for Adjusting Level and Traverse Surveys
By Clarence Norris, and Julius L. Speert, Assoc. M. Am. Soc. C.E.
Detailed suggestions for simplifying computing-room practice.

Charles M. Reppert Dies

THE DEATH of Charles M. Reppert, Vice-President of the Society, occurred on September 16 in Pittsburgh, Pa.

A native of Pittsburgh, Mr. Reppert was born there on October 10, 1880. Following his graduation from Cornell University in 1904, he was employed on the design and construction of a filtration plant for the city of Pittsburgh. He then entered the service of the city of Pittsburgh as chief draftsman, and shortly thereafter was appointed designing engineer in charge of the Division of Design of the Bureau of Engineering, Department of Public Works, remaining in this position until 1917.

During the war Mr. Reppert was associated with the late Morris Knowles, M. Am. Soc. C.E., as deputy supervising engineer on the construction of Camp Meade, Maryland. Upon the completion of this work, he became deputy chief engineer, later chief engineer, and finally assistant general manager of the Housing Division of the Emergency Fleet Corporation, U. S. Shipping Board.

Following the war, Mr. Reppert joined the consulting firm of Morris Knowles, Inc., resigning in 1920 to become chief engineer of the Bureau of Engineering of the Pittsburgh Department of Public Works. In 1922 he established a private practice, which he discontinued upon being appointed assistant director of the newly organized Department of Public Works of Allegheny County. In 1926 he became chief engineer of the Pittsburgh Department of Public Works and during the next ten years had general supervision of all public-work improvements, including major boulevard and street projects, the rehabilitation of the water works systems, bridge construction and reconstruction, and other engineering activities of the city.

CHARLES M. REPPERT

At the time of his death Mr. Reppert was practicing as a civil engineer in Pittsburgh, specializing in the design and supervision of construction of industrial and building projects. In 1936 he served in a supervisory capacity on the completion of the new building of the Mellon Institute of Industrial Research and, later, was chief engineer in charge of the housing plan at the recently completed Irvin works of the Carnegie-Illinois Steel Corporation.

Long active in the affairs of the Society, of which he had been a member since 1913, Mr. Reppert became Vice-President in January 1939. His term would have expired in January 1941. In 1938 he served as president of the Pittsburgh Section of the Society, and he also served for three years on the Society's Licensing Committee.

His death coming so early in his term of Vice-President, Mr. Reppert had hardly become intimate with all the intricacies of his work or with the many members of Zone II which he represented. In western Pennsylvania he was widely known and enjoyed a splendid reputation as an engineer. His standing in the Society was well evidenced in the strong and unanimous endorsements he received in his nomination for office. His many friends will join in feelings of deep regret at the loss of Mr. Reppert to the profession and to the Society.

Papers Filed in Library

ANNOUNCEMENT is made that the following papers have been contributed to the Society for filing with the Engineering Societies Library, 29 West 39th Street, New York, N.Y. Charges for photostating will be quoted by the Library on request.

BEAMS WITH VARIABLE MOMENTS OF INERTIA

ALBERT, ODD, M. Am. Soc. C.E., "The Beam Integrals" (18 typewritten pages, double-spaced; some of them with diagrams). "Often beams with a variable moment of inertia (particularly haunched concrete beams) are designed as beams with constant moment of inertia. Yet this type of beam has the tendency to absorb more moment at the supports, with the result that less moment is left to be taken by the actual beam between the supports. It is shown here how by the introduction of the 'beam integrals' the cantilever design method may be used to find moment coefficients in continuous beams with variable moment of inertia."

BURGHARDT, KING, "Coefficients of Elastic Reactions" (21 typewritten pages, double-spaced, plus 6 pages of tables and diagrams). "Determination of restraint moments in continuous structures composed of members having variable moment of inertia, by means of elastic weight loading, is well known. But in all presentations that have come to the writer's attention only one system of applied loading has been considered. The purpose of this discussion is to expand this method into a systematic, concise procedure, applicable to a large variety of members, which will give influence line values to take care of any loading condition."

TIDAL DATUM PLANES

LEYPOLDT, HARRY, "Tidal Datum Planes" (20 typewritten pages, double-spaced, plus 8 pages of diagrams). The author questions the accuracy of datum planes based upon functions of the tidal regime of the oceans. He points out the existence of differences in mean water level between stations only a few miles apart, and presents data to show a relation between rainfall and other factors and the local elevation of mean sea level. He concludes that "if a national datum plane is deemed a necessity, it should be chosen without relation to any oceanic phenomenon. From it the various changing tidal datum planes can be referenced, and, most important of all, it will be a fixed and not a fluctuating datum."

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

Congressional Actions Affecting the Engineering Profession

HASTILY and superficially characterized as an "economy-minded" and "do-nothing" body, the first session of the 76th Congress adjourned sine die on August 5 after having voted appropriations totaling over $13,000,000 and having enacted a tremendous number of new laws. Although it refused to pass legislation implementing President Roosevelt's plan for self-liquidating loans in the construction and other fields, it voted to spend more money than any preceding session.

For convenience, new legislation closely related to the profession of engineering is reviewed here. It should be noted that, until the 76th Congress legally expires, all proposed legislation on which action has not been completed retains its status and can be further considered and acted upon when Congress reconvenes.

EMERGENCY PUBLIC WORKS

Although a group of Congressmen advocated the appropriation of additional funds to continue the PWA loan-and-grant program, and severals bills were introduced to this effect, the Administration ignored the proposal and the bills languished in committee. Finally, late in the session, President Roosevelt proposed his lending plan as a substitute for the old PWA loan-and-grant system of pump-priming. The lending plan contemplated federal loans at low interest rates to finance projects of a self-liquidating nature to be financed by the sale of government-guaranteed bonds that would be contingent, rather than direct, obligations of the United States. The plan aroused considerable criticism and, although passed by the Senate (52-28) in a modified form, failed of enactment when the House, by a vote of 193 to 160, refused to consider the measure before adjournment. It is, however, still technically before Congress and could readily be revived next session should Congress change its attitude. (S. 2864 and H.R. 7120.)

WORK RELIEF

Activities for the employment of those unable to find work in private industry were curtailed both by reducing the amount of

money appropriated to carry on WPA, NYA, and kindred agencies, and by imposing new restrictions upon their activities. The appropriation for the current fiscal year is $1,755,600,000 (of which $1,477,000,000 is for WPA), compared with a total of $2,539,805,000 voted last year. The prevailing wage rate in WPA is abolished in favor of a security wage based upon the cost of living in each locality, and it is required that workers put in 130 hours each month in order to secure full pay. In each state, local contributions must average at least 25% of the total cost of projects therein, and WPA is barred from constructing any buildings costing over $52,000. (Public Resolution No. 24.)

Continuation of the Civilian Conservation Corps until July 1, 1943, was authorized (Public Law No. 326) and $295,000,000 voted to carry it through the current fiscal year (Public Law No. 8).

Housing

The powers of the Federal Housing Administration, due to expire June 30, 1939, were extended for two years, and the maximum amount of outstanding insurance which it may write increased from $3,000,000,000 to $4,000,000,000. Some changes were made, the more noteworthy being the elimination of the agency's authority to insure multiple-family dwellings costing from $16,000 to $200,000 and the reduction of the size of modernization and repair loans eligible for insurance from $10,000 to $2,500. (Public Law No. 111.)

The adverse reaction to the lending bill also side-tracked a pending bill to increase the limitation on slum-clearance loans by the United States Housing Authority to local authorities from $800,000,000 to double that amount, and to correspondingly add to its limit on annual subsidies. This was passed by the Senate June 8 but its consideration in the House was linked with that given the lending bill and on August 3 consideration of it was deferred. The bill is still alive and will probably be reconsidered next session. (S. 591.)

The Home Owners Loan Corporation was voted authority, at its discretion, to extend the amortization period on outstanding loans where economic considerations justify from the present 15 years to a maximum of 25 years. (Public Law No. 381.)

A census of housing, to be taken as part of the regular 1940 census of population, was authorized at a cost of $8,000,000. Questions will be added to the schedule to develop information regarding the number, character, and geographical distribution of dwelling units and the social and economic characteristics of their ownership and use. (Public Law No. 385.)

National Defense

Perhaps the only recommendation of the President to be accepted by Congress without a quibble was the program to strengthen national facilities for military and naval defense. The program approved is many-sided, and contains a number of items of great interest to engineers, among them the following:

Naval Construction—The Navy is authorized to build aeronautical engine and materials laboratories at the Philadelphia Navy Yard to cost $1,800,000, and to construct shore facilities, including dredging, for naval bases at 13 points on the continent, in Alaska, and on certain Pacific islands at a total cost of $59,650,000. These will be principally for the use of naval aircraft. It may employ outside engineers on a fee basis, not to exceed 6% of the estimated cost of the project, and may negotiate construction contracts on a cost-plus-fixed-fee basis without advertising. (Public Law No. 43.) The Navy is also authorized to expand and modernize its shore establishments in the United States and its possessions to the extent of $53,231,500, to be expended for the construction and repair of dry-docks, explosives manufacturing plants, etc. (Public Law No. 106.)

Strategic Materials—A $100,000,000 program for the purchase and storage of minerals necessary in warfare, of which the principal sources of supply are outside of the United States, is authorized over a four-year period. The Bureau of Mines and the Geological Survey are directed to investigate the possibility of increasing the domestic supply of such essential minerals. (Public Law No. 117.)

Panama Canal—Construction of a third set of locks for the Panama Canal has long been planned as a means of ultimately expanding its capacity. Although not yet necessary for this reason, Congress was impelled by considerations of national defense to authorize the immediate start of this construction at an estimated cost of $277,000,000, which includes not only the locks but other necessary enlargement in channels, structures, and facilities. The first year's appropriation is not to exceed $15,000,000. In carrying out the work the Governor of the Canal is authorized to engage outside technical assistance and to contract, without advertising, for the preparation of plans, specifications, and drawings. (Public Law No. 391.)

Participation by the United States to the extent of $1,500,000 in the construction by the Republic of Panama of a highway outside of the Canal Zone, but desirable as an aid to defense, was authorized. (Public Law No. 200.)

Transportation

Financial reorganization of railroads is facilitated by a bill permitting 25% of a road's creditors to draw up a plan for the reduction of fixed charges and the deferring of maturities for submission to the ICC. If this body approves, and two-thirds of the creditors accept the plan, it is then submitted to a special three-judge U. S. court which will, if it finds the plan equitable to all interests, including the public, enter a decree making the plan effective. The act is effective only until July 31, 1940, and because of the time limitation is expected to benefit only the Baltimore and Ohio and, possibly, the Lehigh Valley, which have such plans ready. (Public Law No. 242.)

The Wheeler bill subjecting water carriers, with some exceptions, to the regulation of the ICC was passed by both Houses but in such different form that a conference committee was unable to agree upon a compromise measure before adjournment. It will be taken up again by the committee in January. (S. 2009.)

Power

Following the negotiation of an agreement for the purchase of electric properties of the Tennessee Electric Power Company by the Tennessee Valley Authority and municipalities in its area, Senator Norris introduced a bill to clear up a legal technicality clouding the right of the TVA to issue and market its bonds to finance the transaction. The result was a bitter struggle that came very close to imposing drastic limitations on TVA activities, and that finally ended in a compromise by which the amount of TVA bonds authorized was reduced from $100,000,000 to $61,500,000, this amount being ear-marked for those purchases in process of negotiation. The net effect was to deprive TVA of nearly $40,000,000 which would otherwise have been available for the purchase of other facilities. (Public Law No. 224.)

A bill to expand the personnel of the Bonneville Administration by authorizing the employment of an assistant administrator, a chief engineer, and a general counsel was passed by both houses in different forms. Adjournment came before the two could be reconciled by a conference committee, so the measure lies in suspense until Congress reconvenes. (H. R. 7270, S. 2375.)

Navigation and Flood Control

This year's flood control bill authorizes no new projects, but directs preliminary examinations and reports on 35 proposed projects, authorizes the President to waive 50% of the statutory requirements for local contributions as respects communities in the Ohio valley unable to participate because of financial conditions, incorporates the Muskingum Valley flood control system in the Ohio Valley project already authorized, and reimburses the District $1,500,000 spent for rights of way. (Public Law No. 396.)

A second bill authorizing the construction of 8 navigation improvement projects and directing preliminary surveys and reports on a large number of others, principally in the field of navigation but in a few cases involving the development of power, was also passed but was vetoed by President Roosevelt because "it is time to go more slowly" and also because the bill contained no provision recognizing the authority of the Federal Power Commission regarding potential power developments. (H.R. 7411.)

Stream Pollution

No action was taken by the House on the Senate-approved bill setting up a system of voluntary loans and grants by the federal government to aid local governments and private industry in the construction of pollution-abatement works, and setting up a new division in the Public Health Service to administer the measure.

Public Roads and Bridges

States that build or acquire toll bridges and make them free before July 1, 1941, may be reimbursed to the extent of 50% of the

fair value from regular federal-aid funds, provided the structures are on the approved federal-aid highway system (either primary or secondary) and conform to federal standards. (Public Law No. 195.)

A bill to permit the transfer of forest lands along federal-aid roads to the states in order to protect natural beauty was passed by the Senate, but not acted on by the House. (S. 231.)

Also approved by the Senate, but still awaiting House consideration is a bill prohibiting the driving of vehicles in interstate commerce by anyone not possessing a driver's license issued by a state in accordance with defined standards, including a test of driving ability and eyesight, and renewal at intervals of not to exceed three years. (S. 25.)

Vetoed by the President was a bill providing that the United States would assume all costs resulting from the alteration of bridges over navigable waters except those directly benefiting the bridge owner. This is a provision of the transportation bill (S. 2009) and was enacted separately as a means of relieving the railroads when it became apparent that the more comprehensive measure would not pass before adjournment. (S. 1989.)

Reclamation

Water users unable, because of crop failure due to water shortage, to pay without hardship the full amount of 1938 water charges, and who were thereby unable to procure water for 1939, were granted an extension of time for payment. (Public Law No. 97.)

General reconsideration of the terms of outstanding repayment contracts with water users is authorized in another bill which provides that such contracts may, at the discretion of the Secretary of the Interior, be revised within the next five years to more equitably conform to the ability of the water users to pay. The overall period of repayment may be lengthened within specified limits, and sliding scales of rates adopted to vary with crop returns and differences in the productivity of project lands. (Public Law No. 260.)

WPA and CCC workers may be utilized in the construction of water conservation projects in arid and semi-arid regions, subject to the repayment of labor and material costs by those benefiting. (Public Law No. 398.)

Both Senate and House passed bills permitting the employment of expert consultants on reclamation work, but in different forms that could not be reconciled before adjournment. (S. 2448 and H.R. 6379.)

Government Employees

Plans for a widespread program of personal administration within government ranks, to include in-service training, reclassification, and competitive promotions, were delayed when the Senate cut an appropriation to finance the procedure from the third deficiency bill. The plan is an important part of the President's program for improvement and expansion of the Civil Service.

Registration of Engineers

A bill for the registration of engineers practicing within the District of Columbia, except those in government service, passed the Senate but was not considered by the House. (S. 1128.)

News of Local Sections

Scheduled Meetings

ALABAMA SECTION—Technical meeting at the University of Alabama on October 2, at 7:30 p.m.

DAYTON SECTION—Luncheon meeting at the Dayton Engineers Club on October 16, at 12:15 p.m.

GEORGIA SECTION—Luncheon meeting at the Atlanta Athletic Club on October 9, at 12:30 p.m.

LOS ANGELES SECTION—Dinner meeting at the University Club on October 11, at 6:30 p.m.

METROPOLITAN SECTION—Technical meeting in the Engineering Societies Building, New York City, on October 18, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Seven Seas Restaurant on October 5, at 7:00 p.m.

NORTHWESTERN SECTION—Dinner meeting on October 2, at 6:30 p.m.

PHILADELPHIA SECTION—Dinner and meeting at the Engineers Club on October 10, at 6:30 p.m.; meeting at 7:45 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

ST. LOUIS SECTION—Luncheon meeting at the Mayfair Hotel on October 23, at 12:15 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers Club on October 17, at 5:30 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers Club on October 30, at 6:00 p.m.

TEXAS SECTION—Fall meeting at Fort Worth, Tex., October 19 to 21.

TOLEDO SECTION—Dinner meeting at the Toledo Club on October 25, at 6:30 p.m.

Recent Activities

DISTRICT OF COLUMBIA—*Washington, August 2:* Special midsummer joint meeting with the Washington Society of Engineers. The feature of this occasion was a talk by Max C. Tyler, brigadier-general, Corps of Engineers, U. S. Army, who discussed developments at Fort Peck Dam. A large number of members and guests turned out to hear General Tyler, who was recently appointed president of the Mississippi River Commission.

GEORGIA SECTION—*Atlanta, August 14:* An inspection trip through the Intrenchment Creek Disposal Plant of the city of Atlanta comprised the meeting. This plant, which was completed in 1937, has a capacity of 14 mgd. The tour was made possible through the courtesy of H. A. Knapp, plant engineer, and W. A. Hansell, assistant chief of construction and engineer of sewers. Mr. Knapp conducted the tour and explained the operation of the plant.

OREGON SECTION—*Portland, August 16:* Following a luncheon, the local members of the engineering board for the Portland sewage disposal project—R. H. Corey, C. E. Green, and Ben Morrow—were introduced. The out-of-town members of the board and speakers for the occasion were then presented. These were Wellington Donaldson, director of the New York City Bureau of Sewage Disposal, and Abel Wolman, professor of sanitary engineering at Johns Hopkins University. The former described briefly the sewage disposal plants in New York City and outlined plans for enlarging these facilities, while Professor Wolman discussed the sewage disposal problem in general, pointing out that disposal facilities must be designed to fit the particular city.

SACRAMENTO SECTION—*August 1, 7, 15, 22,* and *29:* The speaker at the first of these luncheon meetings was M. J. McClelland, optometrist of Sacramento, whose subject was "How Optometry Utilizes Engineering Principles." The program on the 8th was devoted to a résumé of the happenings at the San Francisco Convention, Director Stanton being among the speakers. On the 15th, the Section entertained Field Secretary Jessup, who discussed Society affairs. The other speaker at this session was Charles R. Gallagher, of the California State Division of Highways, whose topic was "Speed Zoning." On the evening of the same day a number of members and their guests went to Pittsburg, Calif., where they inspected the plant of the Columbia Steel Company. The speaker on the 22d was Harry N. Jenks, superintendent of the Sacramento Filtration Plant, who discussed recent developments in sewage disposal. On the 29th, I. W. Collins, load dispatcher for the Pacific Gas and Electric Company, gave an illustrated talk on the subject, "Problems of Electric Power Load Dispatching in Relation to Stream Flow Regulation." *Junior Forum, August 9* and *12:* At the regular meeting on the 9th the speakers were Channing P. Van Camp and Carlton J. Peterson, both Juniors in the Section. On the 12th, the members made an inspection trip to the army air depot near Sacramento.

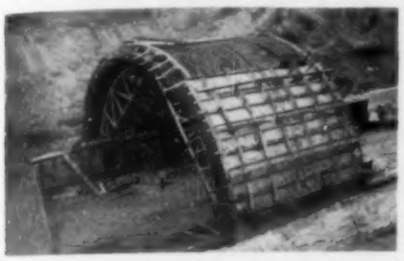
SAN FRANCISCO SECTION—*August 15:* The regular meeting on this occasion consisted of a talk on the subject, "A Clinical Study in Collective Bargaining." This was given by Almon E. Roth, president of the San Francisco Employers' Council. A dinner preceded the meeting.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for November

The Presidio approach to the Golden Gate Bridge, which includes a unique cut-and-cover tunnel and three viaducts, is described by C. H. Purcell in an article scheduled for the November issue of Civil Engineering. Basic considerations in the layout of the project, important items in the structural design, and a graphic description of the interesting and unusual construction methods being employed, are all included in this informative paper.



Tunnel Forms in the Presidio Approach, Ready for the Pour

A thought-provoking discussion of "Possible and Probable Future Floods" is contributed by William P. Creager. Modern methods, he says, have done much to overcome the uncertainties regarding probable floods, but the selection of the "spillway design flood" is still practically a stab in the dark, "since there is at present no indication of the magnitude of possible or probable future meteorological and hydrological occurrences in excess of those experienced in the past." He suggests, as an important problem for further research, the investigation of probabilities in connection with future floods—"not the now obsolete probability curve, but the probability of a storm, of greater magnitude than any that has occurred in the past, centering directly over a given drainage area."

"California State Office Building No. 3," now under construction at Sacramento, is the subject of a paper by W. H. Peterson, also scheduled for November. This building is of reinforced concrete, 307 by 146 ft in plan, and five stories high. "Lateral load design" is of course an important subheading in Mr. Peterson's paper; foundation problems are also discussed at some length.

In the field of highway engineering, William R. Young contributes an article that should develop considerable discussion in ensuing months. "The principal weakness of highway design at this time," he says, "is the lack of a definite objective." He stresses the importance of master plans that should take into account the ultimate development of the highway and to which each improvement project, as it arises, should be made to conform. Numerous suggestions are offered for "elastic construction" designed to reduce the cost of later expansions.

Sanitary engineers will find much of interest in the paper by Messrs. Cox and Holmquist, originally presented at the 1939 Annual Convention, on "Technical and Esthetic Aspects of Watershed and Impounding Reservoir Sanitation." Also on the November list is the second of Professor Rayner's two articles on the history of surveying.

Engineering Vacation Tours

Engineers planning vacation or business trips in the northeastern states will find many valuable suggestions in a pamphlet on "Works of Engineering Interest in New England to Which Engineering Visitors Are Welcomed," recently prepared by the Engineering Societies of New England (715 Tremont Temple, Boston, Mass.). Twenty pages of tables catalog the various works by type—as hydraulic, structural, and so forth—and give the location of each, together with a brief description and the name and address of the person to contact in arranging a visit. This leaflet was prepared especially for the use of those expecting to attend the proposed British American Congress. So it is of immediate value.

For those heading for the Far West, the mimeographed "Tips for Travelers" prepared by the U. S. Bureau of Reclamation, Washington, D.C., are equally helpful. A map shows the location of all federal irrigation projects, and the accompanying text describes the points of interest (including work under construction) and the highway and railway routes that can be taken to reach them. Some of the largest current American operations are included in this valuable list.

Excavations at Roman Coliseum

New evidences of engineering accomplishment in the days of ancient Rome are reported to have been uncovered in recent excavations "backstage" of the great Roman Coliseum. The excavations, which reach a depth of 25 ft, provide proof of there having been 32 elevators which operated in stone elevator shafts. The elevators, with their load of wild animals, were raised to the arena level by counterbalancing weights.

The view of the Coliseum reproduced on the Page of Special Interest (frontispiece of this issue) shows clearly the masonry arches and walls which carried the load of a capacity crowd estimated at 107,000 spectators.

The Coliseum was built in 80 A.D. and the combats ceased by edict of the Consul Honorarius in 404 A.D. after the martyrdom of the monk Telemachus, who rushed into the arena pleading against useless slaughter and was stoned to death by spectators.

Excavating Roman Coliseum

Excavating work (see illustration) will continue for another year so that the remaining parts of the Coliseum can be repaired and saved as a symbol of a past era and to perpetuate the work of engineers of ancient Rome. Photographs and information herein were furnished by Andre La Terza, New York, N.Y.

Backsights

Under this heading it is planned to publish from time to time brief items of a miscellaneous nature regarding Society activities of 50, 40, and 30 years ago. Suggestions from readers will be welcomed.

From the minutes of the meeting of October 2, 1889 (Proceedings, Vol. 15, page 144), comes the following:

"The Society met at 20 o'clock. Vice-President A. Fteley in the chair; John Bogart, Secretary. . . . Ballots were canvassed on the following resolutions:

"*Whereas*, It is a well-known fact that many cities and towns on the Atlantic Coast have suffered very greatly from impurities in their water supplies, due to various causes, and that no adequate remedy, meeting all conditions, has been found therefor; and, *Whereas*, these impurities are often due to natural causes, which have not been adequately investigated on account of the difficulty of centralizing the individual efforts of all parties engaged in said investigations,

"*Resolved*, That a committee of three members of this Society be appointed by

the President, to ascertain the best means of concentrating all obtainable information in such a manner as to secure useful results and to report to the annual meeting of this Society what further action, in their opinion, should be taken in the premises.

"On this resolution there were 235 affirmative and 19 negative votes. This resolution was declared adopted.

"*Resolved*, That a committee be appointed by the Board of Direction to be authorized and instructed to report to the Society a set of standard rail sections of weights, beginning at 40 pounds, and advancing by increments of 5 to 100 pounds per lineal yard.

"On this resolution there were 218 affirmative and 35 negative votes. This resolution was declared adopted.

"*Resolved*, That a committee of seven members of the Society be appointed by the President to recommend uniform methods of testing the materials used in metallic structures.

"On this resolution there were 257 affirmative and 7 negative votes. The resolution was declared adopted.

"*Resolved*, That the same committee be requested to report such requirements for these materials as, in their judgment, may conduce to further improve the grade of such structures.

"On this resolution there were 168 affirmative and 82 negative votes. The resolution was declared adopted.

"A paper on Experiments Relating to Hydraulics of Fire Streams, by John R. Freeman, M. Am. Soc. C.E., was read by the author and discussed by Messrs. Weston and Merriman."

Pigs = Rocks

"TOO MANY assumptions," was the comment of one reviewer regarding a manuscript recently submitted to the Society. "It reminds me," he continued, "of a story Prof. I. O. Baker used to tell about how they weighed pigs in one backwoods section—the pig was tied to one end of a pole over a fence and balanced with rocks at the other end; a guess was then made at the weight of the rocks."

Brief Notes from Here and There

THE 1939 Public Works Congress of the American Public Works Association will be held at the William Penn Hotel in Pittsburgh, Pa., on October 9, 10, and 11. Virtually all phases of public works activity will be discussed, including such topics as public works programming procedure, the new federal public works agency, refuse disposal by sanitary fill, public relations, sewage treatment, and control of subdivision development.

* * * *

"Do You Deserve a Raise?" is the provocative title of an article in *Nation's Business* for August 1939 that should be of interest to young engineers desirous of getting the most out of their jobs. The author of this article, Gelett Burgess, has listed a number of questions by which the employee may grade himself and evaluate his usefulness to his employer. Concrete suggestions for improvement are given.

* * * *

THE engineering profession will be well represented at the sixty-eighth annual meeting of the American Public Health Association, which will convene in Pittsburgh, Pa., on October 15 and continue through the twentieth. Health leaders will be present from Canada, Cuba, Mexico, and many European countries, as well as from every state in the Union, to participate in a scientific program covering the official public health activities of all North America.

* * * *

EFFECTS of the European war on the construction industry will be considered at the annual fall meeting of the governing and advisory boards of the Associated General Contractors of America, Inc., to be held in New York, N.Y., October 2 to 5.

* * * *

CIVIL engineers will be interested in a number of the 130 sessions scheduled for the 1939 National Safety Congress and Exposition, to be held in Atlantic City, N.J., October 16 to 20. Topics for discussion include safety in construction, fire control and prevention, occupational disease control, and street and highway traffic problems.

* * * *

COOLING of concrete dams is one of many topics to be discussed at the symposium on "Temperature, Its Measurement and Control in Science and Industry," which will be held in New York, November 2 to 4. The program is sponsored by the American Institute of Physics with the cooperation of the National Bureau of Standards, the National Research Council, and committees of numerous technical societies. Any interested person may attend and take part in the discussions, and programs containing full abstracts of the papers to be presented will be mailed by the Institute (175 Fifth Ave., New York, N.Y.) on request. Registration fee is $1.00.

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THE NAMES of several members of the Society who received honorary degrees during the past commencement season were listed in the August issue of CIVIL ENGINEERING. To this list can now be added the names of Leo Otis Colbert, director of the U. S. Coast and Geodetic Survey, and Thomas C. Desmond. Admiral Colbert was awarded the honorary degree of doctor of science by Tufts College, while Mr. Desmond received the honorary degree of doctor of humane letters from Union College in recognition of his public service as New York state senator.

NEWS OF ENGINEERS

Personal Items About Society Members

PAUL J. RAVER, formerly chairman of the Illinois Commerce Commission, Chicago, Ill., has been made administrator of the Bonneville Power Project at Portland, Ore.

EDWARD C. HARDING has resigned as PWA project manager of construction in Kentucky to accept the position of vice-president and chief engineer of the Western Waterproofing Company, of Cincinnati, Ohio.

FREDERICK C. TAYLOR is now head of the highway planning division of the Michigan State Highway Department.

CHARLES R. PETTIS, colonel, Corps of Engineers, U. S. Army, retired, has been made a member of the faculty of Mississippi State College, where he will head the department of mathematics.

THOMAS M. ROBINS, brigadier-general, Corps of Engineers, U. S. Army, succeeds BRIG.-GEN. MAX C. TYLER as assistant to the Chief of Engineers, U. S. War Department. In his new post General Robins will have charge of civil works of the Corps of Engineers, including flood control and river and harbor projects. He was formerly stationed at Fort Belvoir, Va.

W. S. LEA, consulting engineer of Montreal, Canada, has been engaged by the city council of St. John, N.B., as consulting engineer for the water-supply improvement being built for the city of St. John.

GEORGE K. LEONARD has been appointed construction engineer for the Watts Bar Dam of the Tennessee Valley Authority. He previously served in a similar capacity on the construction of Guntersville Dam.

CARL F. TELLER was recently appointed assistant engineer of Hardin County, Texas, to take part in an extensive road-building program for that county.

JOHN G. MUNSON, president of the Michigan Limestone and Chemical Company and the Bradley Transportation Company, Rogers City, Mich., has been elected vice-president in charge of raw materials of the U. S. Steel Corporation of Delaware.

WILLIAM A. ZOBEL, lieutenant, Civil Engineer Corps, U. S. Naval Reserve, is now stationed at the Naval Air Base, Astoria, Ore.

BEN S. MORROW, for a number of years engineer and general manager of the City of Portland (Ore.) Water Bureau, is now city engineer for Portland.

D. GRANT MICKLE, until recently manager of the traffic and transport department of Jensen, Bowen and Farrell,

of Ann Arbor, Mich., has been made director of the newly created division of traffic and safety with the Michigan State Highway Department.

V. W. Russell has been transferred from the U. S. Soil Conservation Service at Pocatello, Idaho, where he was area engineer, to the position of resident engineer for the U. S. Bureau of Reclamation at Wenatchee, Wash. Mr. Russell will be in charge of the construction of hatcheries for the control of migratory fish below Grand Coulee Dam.

C. C. Oleson, formerly assistant professor of civil engineering at South Dakota State College, has become district concrete engineer for the Pennsylvania Turnpike Commission. His headquarters are at Somerset, Pa.

Milton Dubin has accepted an appointment as engineering assistant in the office of the Borough President of Manhattan. He was previously in the National Bureau of Standards, Washington, D.C.

Mons H. Benson, associate engineer in the U. S. Engineer Office, was recently transferred from Little Rock, Ark., to Tulsa, Okla., where he will be head of the design group on project planning.

Myron W. De Geer, until lately assistant engineer in the State Board of Agriculture, Kansas Division of Water Resources, is now employed in the U. S. Engineer Department at Tulsa, Okla., in the capacity of junior engineer.

Roy W. Purchase is now a steel detailer in the fabrication division of the Bethlehem Steel Company, with headquarters at Pottstown, Pa. He was formerly in the engineering department of the city of Hartford, Conn.

Arthur Surveyer, consulting engineer of Montreal, Canada, has been appointed head engineer on the construction of the St. Charles trunk sewer in Quebec.

Leo J. Nowicki, former lieutenant-governor of Michigan, is being employed by the Michigan State Highway Commission to make a study of the relationship of Michigan's highways to the new federal inter-regional highway plan.

Elbert A. Baugh has resigned as state director of operations for the WPA in Texas to accept appointment to the position of director of public works for Dallas, Tex. Mr. Baugh will be succeeded by R. W. Colglazier, Jr., who has been serving as assistant state director of operations.

Joseph Marin, formerly assistant professor of engineering materials at Rutgers University, has accepted a position in the civil engineering department at Armour Institute of Technology.

Theodore A. Leisen has announced his forthcoming retirement as general manager of the Metropolitan Utilities District of Omaha, which position he has held since 1923. Although Colonel Leisen's retirement will not take effect until the end of the year, he has been relieved from active service and plans to travel during the next few months.

Benjamin P. Robinson is being transferred from the topographical section of the U. S. Geological Survey at Chattanooga, Tenn., where he was employed as a junior topographical engineer, to the New York District of the U. S. Engineer Corps.

Glenn L. Parker has been named chief hydraulic engineer, Water Resources Branch of the U. S. Geological Survey, with headquarters in Washington, D.C., succeeding Nathan C. Grover, who retired on January 31, 1939. Mr. Parker

Glenn L. Parker

for many years has been district engineer for the Survey at Tacoma, Wash. It will be recalled that he was selected recently by the Board of Direction of the Society to serve as Director from District 12 during the unexpired term of the late Ross K. Tiffany.

Thomas A. Bedford, for twenty-seven years with the California State Division of Highways, Department of Public Works, has retired from his post as senior highway engineer.

John D. Watson, until lately an assistant in civil engineering at the Harvard University Graduate School of Engineering, has recently been appointed assistant professor of civil engineering at Duke University, Durham, N.C.

H. J. Wild, colonel, Corps of Engineers, U. S. Army, will retire from active service on December 1, 1939. For the past five years Colonel Wild has been district engineer for the U. S. Engineer Office at Seattle, Wash.

Charles B. Breed, professor of railway and highway transportation and head of the department of civil and sanitary engineering at Massachusetts Institute of Technology, has been retained by Attorney-General Dever, of Massachusetts, to study the economic possibilities of the New Haven Railroad.

M. J. van Löben Sells, previously on the engineering staff of the Standard Oil Company of California at San Francisco, has become maintenance inspector for the Tide Water Associated Oil Company, with headquarters at Portland, Ore.

E. R. Wintz is now superintendent for M. F. Gaddis, Inc., at Weston, Mass. He was formerly assistant engineer for the Metropolitan Water District of Southern California.

Albert C. Hooke recently accepted appointment as a junior structural engineer in the U. S. Engineer Office at Huntington, W.Va.

C. R. Gallagher, junior traffic safety engineer for the California State Division of Highways, has been awarded one of the Alfred P. Sloane, Jr., fellowships in traffic engineering in the Bureau of Street Traffic Research at Yale University for the coming academic year. Mr. Gallagher was one of seven staff members of state highway departments to be thus honored.

William Atlas has resigned as junior hydraulic engineer in the U. S. Engineer Office at Baltimore, Md., in order to accept the position of engineering assistant with the Board of Water Supply of the City of New York.

Edward S. Bres, colonel Corps. of Engineers, Reserve, was elected president of the Reserve Officers' Association of the United States during the national convention of the association, which was held in San Juan, Puerto Rico, in June. Colonel Bres is a member of the contract, ing firm, Scott and Bres, New Orleans, La.

John C. King, Jr., until last spring instructor in civil engineering at Robert College, Istanbul, has accepted a position as assistant engineer with the New Jersey State Water Policy Commission, with headquarters in Trenton.

DECEASED

Ernest Howard Baldwin (M. '05) president of the Rogers and Baldwin Hardware Company, Springfield, Mo., died on July 28, 1939, at the age of 73. Though a native of Canada, Mr. Baldwin was educated at Cornell University. From 1895 to 1905 he was with the Metropolitan District Water Supply Commission on construction of the Boston supply. In the latter year he became connected with the U. S. Bureau of Reclamation (then the U. S. Reclamation Service), where he remained until 1917. He then spent two years on construction work in Chile and, for two years, was chief engineer for the Sinclair Oil Company. In 1921 he joined the staff of Rogers and Baldwin.

Charles Smith Bilyeu (M. '20) principal valuation engineer for the New York State Public Service Commission, died in New York City on July 21, 1939. He was 53. For a number of years Mr. Bilyeu was structural engineer for the Gulick-Henderson Company, of New York, and as such supervised the steel construction

of many large buildings. At one time he was in the service of the Belgian State Railways, inspecting construction and testing materials, and he served the U. S. government in a similar capacity both during and after the war. He became connected with the New York State Public Service Commission in 1936.

HARRY MCKEAN CONNER (Jun. '31) transitman, Grade 4, for the New York City Board of Water Supply, died recently at the age of 32. From 1925 to 1927 Mr. Conner was with the Hudson Coal Company, and from 1928 to 1929 he was assistant engineer for W. W. Young, consulting engineer. He was connected with the New York City Board of Water Supply from 1929 on, serving as inspector on tunnel construction and in various other capacities.

JAMES EUGENE CURTIS (M. '26) senior engineer in the U. S. Engineer Office, Washington, D.C., died on August 4, 1939. Mr. Curtis, who was 55, had been with the U. S. Engineer Office since 1905. During this period he was employed on waterworks design and building construction. In 1921 he was superintendent in charge of construction of the Dalecarlia filter plant and, for the past ten years, supervised the entire water supply system of the District of Columbia.

PAUL ADAM DIEHL (M. '37) resident engineer for Black and Veatch of Kansas City, Mo., died on August 19, 1939, at Tulsa, Okla., where he had gone to inspect a sewage disposal plant. Mr. Diehl, who was 45, had been with Black and Veatch since his graduation from college in 1919. At one time he served as western representative of the company in charge of their Los Angeles office, and had also been resident engineer on the construction of water works, sewer systems, paving, and other improvements for Kansas City.

CLYDE HENRY FENTON (Assoc. M. '37) office engineer for the Brazos River Conservation and Reclamation District at Temple, Tex., died suddenly on August 7, 1939. He was 41. From 1923 to 1930 Mr. Fenton was underground foreman on nickel operations for the International Nickel Company of Canada, Ltd., at Sudbury, Ontario. From 1930 to 1933 he was in the employ of the Blue Bonnet Tile Company of Houston, Tex., and from 1934 to 1936 senior engineering draftsman for the U. S. Forest Service at Lufkin, Tex. In the latter year he became connected with the Brazos River Conservation and Reclamation District.

GEORGE FARNSWORTH FISK (Assoc. M. '11) of Buffalo, N.Y., died on September 4, 1939, at the age of 60. From 1905 to 1931 Mr. Fisk was in the employ of the city of Buffalo, serving successively as draftsman, assistant engineer, first assistant engineer, and commissioner of public works. In the latter capacities he had charge of all paving and maintenance of streets. In 1931 he resigned from the city service in order to establish a private practice, from which he later retired.

EPHRAIM HARRINGTON (M. '97) consulting engineer of Boston, Mass., died there on July 20, 1939. He was 78. Mr. Harrington, a life member of the Society, devoted practically his entire career to his consulting and advisory practice.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

HERMAN KEENE HIGGINS (M. '17) of Birmingham, Ala., died on August 24, 1939, at the age of 71. From 1898 to 1905 Mr. Higgins was with the New York and New England Railroad and the New York, New Haven and Hartford Railroad. From the latter year until 1910, and from 1913 to 1914 he served in varying capacities with the Isthmian Canal Commission. Later he was with the Aluminum Company of America, the Alabama Power Company, and (from 1929 to 1934) the International Lead Refining Company, East Chicago, Ill.

HAROLD FREDERICK JANDA (Assoc. M. '26) professor of highway engineering and city planning at the University of Wisconsin since 1928, died on July 23, 1939. He was 46. Professor Janda was on the staff of the University of Cincinnati from 1916 to 1921 and of the University of North Carolina from 1921 to 1924 and from 1926 to 1928. He served as assistant director of the Highway Research Board of the National Research Council from 1924 to 1926. When he began his teaching duties at the University of Wisconsin he also became research consultant to the Wisconsin State Highway Commission.

SERGE DE KAREISCHA (M. '94) a native of Russia, died some time ago, though word of his death has just reached Society Headquarters. Professor de Kareischa, a life member of the Society, was for many years professor of the Institute of Engineers of Ways and Communications and a member of the Scientific Technical Counsel of the Commissariate Ministry of Ways and Communications in the Soviet Union.

ARTHUR LESLIE PLIMPTON (M. '96) of West Roxbury, Mass., died on July 16, 1939, at the age of 83. For many years Mr. Plimpton was in charge of the department of civil engineering of the Boston Elevated Railway Company. During this period he directed the remodeling of the entire system of tracks of the West End Street Railway Company (leased by the Boston Elevated Railway Company). In 1916 the department was reorganized, and Mr. Plimpton was made advisory civil engineer. He continued in this capacity until his retirement a few years ago.

CHARLES MILLER REPPERT (M. '13) Vice-President of the Society, died in Pittsburgh, Pa., on September 16, 1939. A brief biography of his career appears in the Society Affairs department of this issue.

FRANK CHARLES WARNER (M. '05) retired engineer of Baltimore, Md., died at Delaware City, Del., on August 18, 1939, at the age of 91. Mr. Warner spent his early career in railroad work and, from 1887 on, was in the U. S. Engineer Department. As assistant engineer in this department, he worked on fortification of the Delaware River. Later he was, for some time, principal engineer in the Office of the Division Engineer of the North Atlantic Division. He retired in 1934.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From August 10 to September 9, 1939, Inclusive

ADDITIONS TO MEMBERSHIP

AGNANO, PAUL (Jun. '38), Graduate Asst., New York Univ., University Heights, New York, N.Y.

AMES, FRANK CLEMENT (Assoc. M. '39), Asst. Hydr. Engr., U. S. Geological Survey, 442 Post Office Bldg. (Res., 1106 Englewood Drive), Chattanooga, Tenn.

AMES, OLIVER RUSSELL (M. '39), Asst. Mgr., Constr. Div., E. I. du Pont de Nemours & Co., 12080 du Pont Bldg., Wilmington, Del.

ANDREWS, HARRY SAMUEL (M. '39), Res. Engr., Glenn D. Holmes, 601 Oneida St., Fulton, N.Y.

BAKER, CLEO ORLAND (Assoc. M. '39), Res. Engr., State Highway Comm., 3600 State (Res., 2021 Sandusky), Kansas City, Kans.

BECKER, DONALD NEIL (M. '39), Engr. of Bridge Design, Dept. of Public Works, City of Chicago, Room 1001A City Hall, Chicago, Ill.

BLISS, THOMAS FRANCIS (Jun. '39), Gen. Insp., Madigan-Hyland, 28-04 Forty-First Ave., Long Island City (Res., 20-05 Cross Island Boulevard, Whitestone) N.Y.

BURLEY, FRED HARVEY (Assoc. M. '39), Res. Engr. of Constr., Dept. of Public Works Sewage Disposal, 9110 West Jefferson (Res. 6804 Vinewood Ave.), Detroit, Mich.

CLAPSADDLE, JACK LINCOLN (Jun. '39), Asst. Research Engr., Iowa Eng. Experiment Station, Iowa State Coll., Ames, Iowa.

CRUISE, JOHN DONALD (M. '39), Programming Engr., State Highway Dept., Lansing (Res., 901 Sunset Lane, East Lansing), Mich.

DOWNEY, PAUL WILLIAM (Jun. '39), Asst. Engr. of Materials, District of Columbia

Gov't (Res., 17 Gallatin St., N.W.), Washington, D.C.

Drake, Alfred C. (Jun. '39), Field Engr., Dravo Corporation, Contr. Div., Pittsburgh, Pa.

Farrag, Nadim (Assoc. M. '39), Asst. Engr., PWA of Pennsylvania, 279 Boas St., Harrisburg (Res., 2738 Freemansburg Ave., Easton), Pa.

Fenzl, Warren Emanuele (Jun. '39), Transitman, Phelps Dodge Corporation, Morenci Branch, Morenci, Ariz.

Ferry, Arlow Vernon (M. '39), Res. Engr., Black & Veatch, Box 173, Halstead, Kans.

Gillett, Paul Newman (Jun. '39), Junior Structural Engr., with Chf. of Engrs. Office, War Dept. (Res., 2900 Connecticut Ave., N.W.), Washington, D.C.

Goit, Laurance Edward (M. '39), Engr. in Chg., Distrib. Div., Bureau of Water Works and Supply, 410 Ducommun St., Los Angeles, Calif.

Hartzog, Octavius Bowen (Assoc. M. '39), Vice-Pres., Spence & Howe Constr. Co., Box 286, Port Arthur, Tex.

Hatfield, Robert John (Assoc. M. '39), Associate Highway Engr., State Div. of Highways, 808 State Bldg., Los Angeles (Res., 2202 Montezuma Ave., Alhambra), Calif.

Helland, Randolph Olaf (Assoc. M. '39), Associate Engr., U. S. Geological Survey, Washington, D.C.

Hicks, Newton Franklin (Jun. '39), Asst. Project Engr., WPA (Res., 2439 Browne St.), Omaha, Nebr.

Hodges, Edward Bonneau (Jun. '39), Junior Hydr. Engr., U. S. Geological Survey, 220 Post Office Bldg., Asheville, N.C.

Hoffman, William Joseph (Jun. '39), Detailer, Seaboard Steel Products Corporation, 205 East 42d St., New York, N.Y. (Res., 1067 Arlington Ave., Plainfield, N.J.).

Hopkins, Elmer Woodson (M. '39), City Engr., City Hall, Salina, Kans.

Jugo, Lionel (Jun. '39), Care, Caribbean Petroleum Co., Maracaibo, Venezuela.

Lester, Herbert Hamilton (M. '39), Regional Engr., SCS, U. S. Dept. of Agriculture, 4th Floor, Kuhns Bldg., Dayton, Ohio.

Luna, William August (Jun. '39), Y. M. C. A., Newburgh (Res., 704 East 182d St., New York), N.Y.

MacConnell, Richard Joseph (Jun. '39), Asst. Engr., U. S. Forest Service, 3437 Woodland Ave., Philadelphia (Res., 704 South 24th St., Harrisburg), Pa.

McFarland, Frank Ray (M. '39), Supt. of Constr., Sheffield Steel Corporation, Kansas City, Mo.

Marsh, Ralph Eastman (Assoc. M. '39), Associate Engr., U. S. Geological Survey, Louisiana State Univ., University, La.

Paul, Frederick Thornton (M. '39), City Engr., 203 City Hall, Minneapolis, Minn.

Petern, James (Jun. '39), Junior Engr. Insp., PWA, Box 357, Angola, Ind.

Porteus, John Horton (Assoc. M. '39), Design Engr., Jackson & Moreland, 31 St. James Ave., Boston (Res., 17 Alden St., Newton Highlands), Mass.

Price, Westcott Wilkin, Jr. (Jun. '39), Job Engr., Ford J. Twaits Co., 816 West 5th St., Los Angeles (Res., 1329 North Columbus Ave., Glendale), Calif.

Reaves, John Cable, Jr. (Jun. '39), With Standard Oil Co. of California, 316 Fillmore St., Taft, Calif.

Reitter, Arthur Ried (Jun. '39), Designer, Hydr. Design Dept., Central Nebraska Public Power and Irrig. Dist. (Res., 211 North Elm), Hastings, Nebr.

Renshaw, Claude Downer (Jun. '39), Flying Cadet Detachment, Kelly Field, Tex.

Riedel, Carl Martin (Assoc. M. '39), Designing Engr., Bureau of Eng., City of Chicago, 3d Floor, Navy Pier, Div. of Water Purification (Res., 8022 Paxton Ave.), Chicago, Ill.

Shuman, Everett Carlyle (Assoc. M. '39), Chairman, Dept. of Civ. Eng., Lewis Inst., 1951 West Madison St., Chicago, Ill.

Smith, Donald Lee (Assoc. M. '39), Acting County Engr., Mobile County (Res., 2161 Homewood St.), Mobile, Ala.

Sparks, Roberts Richardson (Assoc. M. '39), Engr., The Empire Constr. Co., 31 South Calvert St., Baltimore, Md.

Stokes, Herbert Raymond (Jun. '39), Junior Hydr. Engr., TVA, 700 Union Bldg. (Res., 221 Keeble St.), Knoxville, Tenn.

Ter Maath, Bernard Herman (Jun. '39), Junior Engr., U. S. Engr. Dept., U. S. Engr. Office, Rock Island, Ill.

Tsutsumi, Kentaro (Jun. '39), Senior Civ. Eng. Draftsman, Met. Dist. Water Supply Comm., 20 Somerset St. (Res., 103 Beacon St.), Boston, Mass.

Voorhies, Louis Joseph (M. '39), Cons. Engr., City Hall, Baton Rouge, La.

Membership Transfers

Adams, Thomas Caldwell (Jun. '24; Assoc. M. 34; M. '39), Associate Prof., Civ. Eng., Univ. of Utah, (Res., 242 South 12th East St.), Salt Lake City, Utah.

Batson, Benjamin Arthur (Assoc. M. '30; M. '39), Constr. Adviser, USHA, 15th and Tamarind (Res., 502 Thirty-Seventh St.), West Palm Beach, Fla.

Binnie, William James Eames (M. '29; Hon. M. '39), Civ. Engr. (Binnie, Deacon & Gourley), Artillery House, Artillery Row, Victoria St., Westminster S.W. 1., London, England.

Boucher, Raymond (Jun. '34; Assoc. M. '39), Prof. of Hydraulics, Ecole Polytechnique de Montreal, 1430 Rue St. Denis, Montreal, Canada.

Carlson, Carl Harold (Jun. '30; Assoc. M. '39), Constr. Engr., The Weitz Co., Inc., 713 Mulberry St. (Res., 1022 East 8th St.), Des Moines, Iowa.

Case, John Gideon (Jun. '29; Assoc. M. '39), Structural Engr., Warner Bros. Pictures, Inc., Burbank (Res., 2360 Lorain Rd., San Marino), Calif.

Cohn, Morris Mandel (Assoc. M. '34; M. '39), San. Engr., City of Schenectady, City Hall, Schenectady, N.Y.

Eberhart, Howard Davis (Jun. '36; Assoc. M. '39), Asst. Prof., Civ. Eng., Univ. of California, Eng. Materials Laboratory, Univ. of California, Berkeley, Calif.

Fischer, Victor William (Jun. '29); Assoc. M. '39), Chf. Transitman, N. Y. C. R. R., Room 15, West Shore Terminal, Weehawken, N.J. (Res., 340 Mosholu Parkway, South, New York, N.Y.)

TOTAL MEMBERSHIP AS OF SEPTEMBER 9, 1939

Members	5,572
Associate Members	6,193
Corporate Members	11,765
Honorary Members	29
Juniors	3,777
Affiliates	72
Fellows	1
Total	15,644

Fruechtenicht, Herman Louis, Jr. (Jun. '30; Assoc. M. '39), Supt., Consumers Power Co., Box 654, Edmore, Mich.

Fugate, Douglas Brown (Jun. '34; Assoc. M. '39), Res. Engr., State Dept. of Highways, Franklin, Va.

Hopkins, William Joseph (Jun. '29; Assoc. M. '39), Asst. Engr., Engr. Corps, U. S. A., U. S. Engr. Office, 1001 Chamber of Commerce Bldg., Pittsburgh, Pa.

Howat, Philip Yvone Kirkpatrick (Assoc. M. '26; M. '39), Pres., Howat Concrete Co., Inc., 2 S St., S.W., Washington, D.C. (Res., 1041 St. Paul St., Baltimore, Md.)

Intemann, Henry Luther (Jun. '32; Assoc. M. '39), Senior Eng. Draftsman, U. S. Forest Service, Post Office Bldg. (Res., 709 Parkland Circle), Albuquerque, N.Mex.

Johnson, LeRoy Francis (Assoc. M. '33; M. '39), Maintenance Engr., State Highway Dept., Concord, N.H.

Milnamow, Arthur (Jun. '31; Assoc. M. '39), Civ. Engr., Curtis Pub. Co., Philadelphia, Pa. (Res., 907 Belmont Ave., Collingswood, N.J.)

Murray, Howard Slater (Jun. '28; Assoc. M. '30; M. '39), Pres. and Chf. Engr., Uniflow Pump Co. (Res., 5436 Westhaven St.) Los Angeles, Calif.

Reeves, James Edson (Jun. '29; Assoc. M. '39), Senior Civ. Engr., Office of Designing Engr., The Panama Canal, Balboa Heights, Canal Zone.

Slaton, Alan Lee (Jun. '36; Assoc. M. '39), Junior Asst. Engr., State Dept. of Public Works, 122 West Main St., Babylon (Res., 405 West 23d St., New York), N.Y.

Taggart, Robert Strangeway (Jun. '29; Assoc. M. '39), Dist. San. Engr., State Health Dept., 268 Guy Park Ave., Amsterdam, N.Y.

Terry, Jack Montgomery (Jun. '30; Assoc. M. '39), Asst. Hydr. Engr., U. S. Geological Survey, Water Resources Branch, 119 U. S. Court House, Columbia, S.C.

Wheeler, Frank Wirtly (Jun. '36; Assoc. M. '39), Senior Bridge Designing Engr., Bridge Eng. Office, State Dept. of Highways, Highway Comm. Bldg., Richmond, Va.

Wheeler, Robert Marret (Jun. '27; Assoc. M. '39), Engr., Henry C. Hibbs, Am. Trust Bldg. (Res., 1412 Seventeenth Ave., South), Nashville, Tenn.

Reinstatements

Arneberg, Birger Haaversen, Assoc. M. reinstated Sept. 5, 1939.

Auer, Philip Fenton, Assoc. M., reinstated Sept. 1, 1939.

Bailey, Kenneth McGrath, Assoc. M., reinstated Aug. 28, 1939.

Baker, Russell Ephraim, Assoc. M., reinstated Sept. 5, 1939.

Bilderbeck, George Leslie, M., reinstated Aug. 28, 1939.

Blackwell, Fred Gaius, M., reinstated Aug. 24, 1939.

Conahey, George, Assoc. M., reinstated Aug. 15, 1939.

DeTreville, Alfred Louis, Assoc. M., reinstated Sept. 6, 1939.

Fisher, Harold Preston, M., reinstated Aug. 21, 1939.

Green, John Norvell, Assoc. M., reinstated Aug. 24, 1939.

Harris, Richard John, Jun., reinstated Aug. 31, 1939.

Hess, Harry Clair, M., reinstated Sept. 1, 1939.

Kuhn, Percy Coleman, Assoc. M., reinstated Sept. 5, 1939.

Kunkle, Charles William, M., reinstated Aug. 22, 1939.

Larsen, William Schroeder, Assoc. M., reinstated Aug. 30, 1939.

Sherman, Harold, M., reinstated Aug. 21, 1939.

Stepleton, Harold Austin, Assoc. M., reinstated Aug. 28, 1939.

Stickney, Enoch Morgan, M., reinstated Sept. 5, 1939.

Stocking, Ernest Joseph, Assoc. M., reinstated Aug. 28, 1939.

Thomas, Dan Horace, Assoc. M., reinstated Aug. 22, 1939.

Tillson, Harold Luther, Assoc. M., reinstated Aug. 30, 1939.

Wallace, Allan Lanham, Assoc. M., reinstated Aug. 30, 1939.

White, Duane Kidder, Assoc. M., reinstated Sept. 1, 1939.

Wood, William Alfred, Assoc. M., reinstated Aug. 21, 1939.

Resignations

Curl, Stoddard Whinfield, Jun., resigned Aug. 25, 1939.

Fickes, Eugene Weldon, Assoc. M., resigned Aug. 17, 1939.

Hoffmann, Reyburn Paul, Assoc. M., resigned Aug. 11, 1939.

Owen, William Victor, Assoc. M., resigned Aug. 15, 1939.

Strickland, Richard Porter, Assoc. M., resigned Aug. 11, 1939.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

October 1, 1939 NUMBER 10

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in CIVIL ENGINEERING *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

APPLYING FOR MEMBER

ANGELOTTI, JAMES ALOIS, Rankin, Pa. (Age 40) (Claims RCA 1.2 RCM 10.9) June 1938 to date Borough Engr., Rankin, Allegheny County, Pa., having title, Supt. of Public Works; previously Borough Engr., Trafford, Westmoreland County, Pa.; Engr., East Pittsburgh Borough, Allegheny County, Pa.

BAILEY, PAUL SHIELDS (Assoc. M.), Denver, Colo. (Age 50) (Claims RCA 5.8 RCM 10.0) April 1922 to date with Colorado State Highway Dept. as Draftsman, Asst. Bridge Engr., and (since Aug. 1925) Bridge Engr.

BOUGHTON, VAN TUYL (Assoc. M.), Plainfield, N.J. (Age 51) (Claims RCA 8.4 RCM 16.5) March 1923 to July 1928 Asst. Editor, and July 1928 to date Managing Editor, Engineering News-Record, New York City.

CARROLL, MARION EDMUND, San Benito, Tex. (Age 38) (Claims RC 11.7 D 7.3) Nov. 1933 to Feb. 1936 and Feb. 1937 to date Asst. Engr., International Boundary Comm.; in the interim Dist. Field Supervisor, WPA, and Office Engr., Willacy County Water Control and Improvement Dist. No. 1, Raymondville, Tex.

CLASSEN, ASHLEY GREEN (Assoc. M.), El Paso, Tex. (Age 36) (Claims RCA 7.3 RCM 7.1) Jan. 1936 to date Supt. and Chf. Engr., El Paso (Texas) Dept. of Water and Sewerage; previously State Reclamation Engr. of Texas, Austin, Tex.; Dist. Engr., FERA, Dist. No. 20, El Paso, Tex. in charge of FERA Works Program in 26 counties.

DYMOCK, JONATHAN LEON, Tenafly, N.J. (Age 43) (Claims RCM 18.2) March 1935 to date Engr. Inspector and Engr., PWA, New York City; previously Archt. and Engr. with K. B. C. Smith, Bldr., Englewood, N.J.; since July 1922 also in private practice as Archt. and Engr.

FORSBERG, GEORGE WILHELM, Albany, Calif. (Age 54) (Claims RC 7.3 D 10.0) June 1933 to date with U. S. Govt., successively with Forest Service, Bureau of Public Roads, War Dept., WPA, City of San Francisco, and (since July 1938) Asst. Structural Engr. Navy Yard, Mare Island, Calif., designing and inspecting large building.

HOOD, JAMES HENRY (Assoc. M.), Boston, Mass. (Age 57) (Claims RCA 5.2 RCM 29.6) April 1905 to date with Stone & Webster Eng. Corporation, successively as Field Engr., Asst. to Supt. of Constr. and Purchasing Agt., Constr. Engr., Asst. Supt. of Constr., Locating Engr., Office Engr., Res. Engr., Asst. Supt., Supt. of Constr., Asst. to Hydr. Engr., Appraisal Engr., Asst. Constr. Mgr., Director Gen. of Constr., and (since Dec. 1926) Vice-Pres.

HUDSON, GEORGE HENRY, New Orleans, La. (Age 40) (Claims RCA 7.0 RCM 9.3) Oct. 1930 to date with U. S. Engr. Dept. as Asst. Engr., Associate Engr., and (since July 1932) Associate Engr. and Engr. being Head of Eng. Div. of Dist. Office.

IRVIN, WILLIAM PAUL, Washington, D.C. (Age 58) (Claims RCA 2.9 RCM 16.0) July 1936 to date with WPA as Estimator; previously Cons. and Superv. Engr. for various clients and on own projects.

JOHNSON, THEODORE SEDGWICK (Assoc. M.), Raleigh, N.C. (Age 54) (Claims RCA 0.9 RCM 29.8) Jan. 1933 to date Prof. of San. Eng., North Carolina State Coll. of Agriculture and Eng.; March 1935 to date Chf. Engr., North Carolina Dept. of Conservation and Development; July 1936 to date Consultant, North Carolina State Planning Board.

McNOWN, WILLIAM COLEMAN (Assoc. M.), Lawrence, Kans. (Age 59) (Claims RCA 10.3 RCM 17.7) July 1935 to date Engr., Douglas County Kaw Drainage Dist., in charge of flood-protection work along Kansas River; Sept. 1913 to date at Univ. of Kansas as Asst. Prof., Associate Prof. in Civ. Eng., Prof. of Highway Eng., and (since Sept. 1934) Prof. of Civ. Eng., being Chairman of Dept.

WARNOCK, JACOB EUGENE (Assoc. M.), Denver, Colo. (Age 36) (Claims RCA 6.1 RCM 6.0) Sept. 1931 to date with U. S. Bureau of Reclamation as Associate Civ. Engr., and (since Sept. 1935) Hydr. Research Engr. in charge of hydraulic investigations on dam and canal structures.

WILLIAMS, LEON G. (Assoc. M.), Toledo, Ohio. (Age 45) (Claims RCA 13.6 RCM 7.5) July 1928 to date with Greeley & Hansen, Chicago, on hydraulic and sanitary engineering.

APPLYING FOR ASSOCIATE MEMBER

ALLEN, PHILIP BERTRAM (Junior), Chattanooga, Tenn. (Age 32)(Claims RCA 2.0) Feb. 1935 to date with TVA as Senior Eng. Aide, Jun. Highway Bridge Engr., and (since June 1937) Asst. Structural Engr.; previously Inspector U. S. Engr. Office.

BATEMAN, ALFREDO DUDLEY, Bogota, Colombia. (Age 30) (Claims RC 3.8) May 1936 to date with San. Eng. Div., National Health Dept. (Aug. 1938 incorporated into Ministry of Labor, Health, and Social Planning), successively as Visiting Engr., Jan. 1937–Dec. 1938, First Asst. Engr., and (since Jan. 1939) Asst. Chf., also Chf. Engr., Social Assistance Works Div.

BIRKELAND, HALVARD WESSEL (Junior), Denver, Colo. (Age 32) (Claims RCA 3.9 RCM 0.0) May 1934 to date with Bureau of Reclamation as Jun. Engr., and (since June 1937) Asst. Engr.

BOARD, LEONARD MARVIN (Junior), Clayton, Mo. (Age 32) (Claims RCA 2.1 RCM 0.3) Jan. 1938 to date Director, Div. of Sanitation, St. Louis County Health Dept.; previously San Engr., Hillsdale (Mich.) County Health Dept.

BRADFORD, THOMAS ALDEN, Washington, D.C. (Age 33) (Claims RC 2.2 D 3.8) Jan. 1930 to date Asst. Engr., Capital Transit Co.

CHADERTON, JULIAN CUTHBERT, Chicago, Ill. (Age 44) (Claims RCA 4.0 RCM 6.0) Sept. 1936 to June 1939 student, Armour Inst. Tech.; May 1929 to Aug. 1936 Surveyor and Mine Supt., Coupland Gold Mines, Ltd., Northern Ontario and Manitoba; previously Observer Geodetic Survey of Canada.

CLINTON, EDGAR THOMAS, Yellowstone Park, Wyo. (Age 33) (Claims RC 2.3 D 0.8) Jan. 1939 to date Asst. Archt., National Park Service; previously Structural Draftsman, Shell Oil Co.; Draftsman, Soule Steel Co.; Area Supervisor, WPA of Illinois, Dist. 1, Rockford, Ill.

COLLINS, REX IVAN, McAlester, Okla. (Age 31) (Claims RCA 0.0 RCM 4.1) May 1937 to date Contr. and Engr. (private practice); previously Dist. Engr., FERA and later WPA; Asst. Dist. Engr. with CWA and FERA.

CONDUSO, GENARO (Junior), Newark, N.J. (Elected Oct. 14, 1930.) (Age 32) (Claims RCA 7.2 RCM 0.0) July 1930 to July 1933 and May 1939 to date Eng. Draftsman and Senior Draftsman, New Jersey State Highway Dept.; in the interim Constr. Engr., Franklin Constr. Co., Project Planner, New Jersey State ERA, Office Engr., Faitoute Iron and Steel Co., Concrete Draftsman, Jos. T. Ryerson and Sons, Inc., Structural Draftsman, The Port of New York Authority.

COOK, ROBERT (Junior), New York City. (Age 32) (Claims RCA 3.7 RCM 2.7) April 1939 to date Supt., National Excavation Corporation, Inc.; previously Field Engr. and Asst. Supt., Elmhurst Contr. Co., Corona, L.I.; Chf. Engr. and Supervisor, Bryant Contr. Co., New York City; Res. Engr., L. P. O'Connor, Inc.; Field Engr., Albert A. Volk, Inc.

DAWSON, CHARLES OATLEY (Junior), Columbus, Ohio. (Age 32) (Claims RCA 5.1 RCM 0.0) Sept. 1930 to date Instructor in Civ. Eng., Coll. of Technology, Univ. of New Hampshire, Durham, N.H.; 1930 to date in private practice; Sept. 1939 to date (on leave of absence) graduate student, Ohio State Univ.

DRUDING, HENRY ANTHONY (Junior), East Orange, N.J. (Age 31) (Claims RCA 5.5 RCM 0.0) April 1933 to date with The Port of New York Authority as Freight Elevator Operator, and (since March 1934) Jun. Engr., Engr. Dept., Constr. Div.

GALLOGLY, RALPH FRED (Junior), Cuyahoga Falls, Ohio. (Age 32) (Claims RCA 8.3 RCM 0.0) July 1939 to date Structural and Architectural Designer, Firestone Tire & Rubber Co., Akron, Ohio; previously Asst. Production Engr., United Conveyor Corporation, Chicago, Ill.; Camp Comdr., U. S. War Dept., CCC, Boise, Idaho, Dist.; Asst. Structural Engr., Columbia Eng. Corporation & Union Gas & Elec. Co., Cincinnati, Ohio.

HIGHLAND, SCOTLAND G, Clarksburg, W.Va. (Age 60) (Claims RCA 27.3 RCM 0.0) Feb. 1906 to date with City of Clarksburg and Clarksburg Water Board as Asst. to Mgr. and